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Iron and Steel Engineer

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J. F. KELLY, *Editor*

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All Meetings in the Green Room of the Thomas Jefferson Hotel, Birmingham, Alabama

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NOVEMBER 29, 1930

"LOCATION OF NEW INDUSTRIES IN ALABAMA," by Mr. John R. Lester, of New Industries Department of Alabama Power Company.

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"FAN COOLED ENCLOSED MOTORS," by Mr. A. M. MacCutcheon, Engineering Vice President, Reliance Electric and Engineering Company.

FEBRUARY 28, 1931

"HOW AND WHY VACUUM TUBES ENTER THE ELECTRICAL FIELD," by Mr. W. C. White, Vacuum Tube Engineering Department, General Electric Company.

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"LATEST DEVELOPMENTS IN UNIVERSAL PLATE MILLS," by Mr. E. S. Lammers, General Engineer, Westinghouse Electric and Manufacturing Company, Atlanta, Georgia.

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"REYROLLE SWITCH GEAR," by Mr. J. D. Greensward, Engineer, Allis Chalmers Company, Milwaukee, Wis.

MAY 30, 1931

"ANNUAL OUTING," Place to be announced later.

ALABAMA SECTION

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EDITORIAL

For the past fifteen months the Iron and Steel Industry, together with the balance of the industries in America, have faced an economic depression, the length of which we know not, but the width of which we have experienced.

The leaders, the captains of our industries, predict that from now on our conditions will improve, slowly perhaps, but steadily.

Millions of dollars have been spent in 1930 in the Iron and Steel Industry to modernize our present existing equipment and over one hundred million dollars has been invested in new plants, new mills in the hope that with the return of prosperity the demands of the people in the United States will exceed the sources of supply. This condition will make for the happiness and contentment, not only for the people at large, but for those who possessed the foresight and courage to invest in the "futures" of our country.

To the everlasting credit of the leaders of the Iron and Steel Industry one factor in this depression was missing, "Destructive Competition" and the wholesale give it away policy was not adopted nor encouraged. Healthy competition we must and always will have with us, for this denotes progress in methods, processes and application.

Engineering competition will be much keener in the future than it has been in the past. Radical changes in the application of apparatus used to process and produce iron and steel may be expected.

The giants of industry will be effected, much more so than the small independent and there is still plenty of work to be done. The human element will have less to do with the operation of our plants, many of the operations of today will, in a short time, be performed by the clock, mills started and stopped, lights on and off, valves turned and reversed, fires turned on or off, only the human mind, not the hand will function.

What does this mean? It means that the Iron and Steel Plants must allow their engineers more freedom of action in their future experiments and operations, more time to develop their ideas, more time to travel in their inspections and last, but not least, the hearty active support of all engineering societies, which after all, are clearing houses for the exchange of ideas and opinions, of the results obtained in the field of research, development and operation.

Progressive engineering, keeping abreast of the times, is not to be obtained within closed fences, but to be successful in the future, continued human contact with the fellow man must be everlastingly maintained. This and only this will be the price of progress, in costs, quality and production. The Steel Industry's engineering motto in the past has been "Knock and the door shall be opened," in the future the motto should be "The doors are always open."

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"Happy Days Will Come Again"

By WRAY DUDLEY*

By the time this issue of the Iron and Steel Engineer has reached the members of the Association, we will have entered into what a fairly good sized portion of civilized mankind calls a "New Year." Probably to many of us the most tangible evidence of its newness will lie in the presence of brand-new calendars on our desks or the office wall, while the wind-tossed and service marked remnants of the old ones repose in the waste basket. Otherwise, we pay but scant attention to the fact that old Mother Earth has once again completed her majestic whirl around the sun and that Father Time has also cancelled one more of the all too few years allotted to each of us. By our observance of the holiday customs, we do give a somewhat joyous recognition to the passing of the Old Year and the coming of the New. But in these hectic, rushing "modern" days, we have practically abandoned the old-fashioned custom of looking back over the events of the previous twelve months to see whether we had made a little progress toward our desired goal or whether we had inadvertently headed into some profitless by-ways. However, the pace has slowed down a little during recent months, and since we are not so busy just now, going places and seeing things, perhaps it will not be amiss to take a small amount of space in this issue of the Engineer for a short resume of recent events which have touched many of us, and also to give a little thought to the present and future as well. And, for once at least, let us take our minds off technical matters and mill affairs and consider what is happening in the world in which we live.

At the beginning of 1930, we had just passed through one of the most remarkable commercial periods in American history. We had witnessed a wave of unprecedented industrial activity suddenly terminated by a stock market crash never before equalled in its wide spread and disastrous results. The rising tide of National prosperity had permeated all lines of industry, including our own. Peak production in all lines had been matched by a consuming power in the nation which seemed to be without limit. Courage, optimism and confidence in the future appeared to permeate all classes and there was no limit to our belief in what we could accomplish once we decided to go ahead.

Perhaps we became a little over-confident, a little boastful, a little careless in reaching conclusions. In other words, perhaps there was a little of the proverbial pride which precedes the usual fall. In a desire to secure quickly a portion of the riches which seemed within reach of everyone and thus achieve with little effort some of the longed-for blessings (?) which a small portion of unaccustomed wealth might be expected to bring, many of our citizens dug down in the old sock and brought their hard-won surplus to the market place and there entrusted it to the indifferent care of other gentlemen equally optimistic and uninformed as to our Country's immediate future.

All through the Spring and Summer of 1929, everything was fine, and even into early Fall, the financial skies were clear. True, there had been warning signals which might impress the cautious and canny observer: the farmers weren't as happy as they might be, the little home buyer wasn't as plentiful as formerly, and some were slow with their payments, unemployment was being talked about as being a little troublesome, the market price of many popular securities gave but meagre return on their earnings, and a few pessimistic old codgers issued gloomy words of warning. But we were sailing along—the "most prosperous Nation on earth," we were a young, strong, vigorous people, at peace with the world, concerned only in our own domestic affairs and the development of our Country. Our Government was in the hands of business men, we had a new type of citizen for President, a man who had received the training of an engineer, who had made an eminent success of his own affairs and who had acquired international renown through his administrative aid rendered to whole Nations in distress. Material evidences of a prosperous people were to be seen throughout the land, crowded schools, busy recreational centers, telephones, radios, automobiles—all the means for acquiring culture and a full enjoyment of life which plenty of ready money could provide.

And then came the last days of October, 1929, when with appalling suddenness the sentiment of the people changed, confidence turned to doubt, doubt to fear and fear to panic. Faster even than the wires could tell the story, a financial rout developed in New York and spread throughout the Country, extending even to foreign shores. Within a few short business hours, our national wealth, as represented by the security values of all its manifold business enterprises, had vanished to the extent of billions of dollars, and with them went the wealth of millions of little investors throughout the land. The blow fell with such startling swiftness and was so widespread in its disastrous effects that very few appeared to realize its ultimate significance. The vanished values were said to be mostly paper losses and that the real wealth of the Nation was practically untouched. We were told that the situation was only temporary, and in fact might be considered as simply a healthy reaction to a period of overextended prosperity. Prophecies for a rapid recovery were freely made by practically every voice which reached the public. Most of these optimistic statements, of course, originated from those gentlemen to whom a desperate wish must have been father to the thought. They must have sensed all too well what a dangerous situation faced the Country and hoped by a general restoration of public confidence to save at least some portion of the wreckage.

The millions of little losers throughout the Country were silent as usual, they had ventured and had lost and accepted the consequences with the best grace possible. Their hope was buoyed up to some extent by the optimistic and hopeful statements, originating for the most part in investment circles, all based on very satisfactory annual earnings for 1929, and broadcast throughout the Country. At

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the same time, published information regarding the general slackening of industry was slow to come through. No one was very keen to broadcast the bad news that automobile production had practically ceased and that the mills dependent upon them for a large part of their output were banking their fires that the radio producers were simply swamped in their own unabsorbed production, or that the ranks of the unemployed were rapidly increasing.

It required weeks and months of such business straws as these to show the general public which way the industrial wind was blowing. Before the real situation was generally known, we came to the end of the year and entered 1930 hoping that the bad news which came through in ever increasing volume would soon cease. From the highest sources in the land came reassuring statements. Even the White House gave out optimistic comments on the unemployment situation. The press was filled with information regarding plans for the construction of Government buildings and other large improvements as an aid to stimulate business. The public utilities took advantage of the reduced equipment prices and appropriated huge sums for bettering their facilities. Highway construction was pushed to the limit of the funds available and many States and Municipalities appropriated additional sums for needed improvements, which, under other circumstances, could have been postponed to other years. "Buy now" campaigns were organized in support of many non-essential lines of merchandise, while a general lowering of retail commodity prices encouraged the individual consumer to do his part in stimulating trade.

Whether these efforts were directly responsible for it or not is, of course, unknown, but there was a definite revival of public confidence during early months of the year which seemed to spread throughout the Country and the business situation began to look more hopeful. The growing spirit of optimism was reflected in the security market where prices began to creep back towards previous high levels. It looked as if all the determined effort which had been expended by our business leaders might enable us to escape further disaster. But the weather took a hand in the game and rain ceased to fall, a drought became prevalent throughout the Country and our farmers found themselves in sore straits. What with forage crops burned out and facing a diminishing water supply, they were compelled to dump their live stock on a glutted market and accept the losses as they came. The wheat hold-over from 1929 and the abundant crop of 1930 toppled the market for this basic commodity and the farmers were still further harassed by prices below the cost of production. About this time, it was noticed that steel production began to slump and showed no ability to recover, car loadings diminished, first and second quarter earnings of the big corporations showed disheartening declines, the unemployment situation became more troublesome and even the best efforts of our tariff tinkers failed to get the hoped for results. In no quarter of the business world could encouraging prospects be found. Despite the continued flood of optimistic messages and Pollyanna talk, the conviction gained ground among the people that the depression was more than temporary and that something besides words would be necessary before sound business conditions could again be enjoyed for any reasonable period of time. The National result of this pessimistic conclusion again became evident during October in rapidly declining security values. They came down with slightly less speed than they did a year ago, but down they came with no less certainty and to levels practically as low. Once more billions of dollars in security values vanished within hours and from hundreds of thousands of little investors went real dollars also, the dollars which, in many cases, had been dragged out from hoards, hidden against the need of a rainy day and now used in a vain effort to protect all too slim margins which they had never been able to strengthen during a year filled with doubt and deferred hopes. Perhaps it is too early to sense the ultimate results, but on this occasion commodity prices have thus far held their own, in fact they have shown some signs of improvement, and this is the one encouraging phase of an otherwise gloomy prospect.

And now we are entering the New Year of 1931 with a bright, clean page before us on which to write the history of another business year. What will the story be, will it be one of improvement or will it disclose further recessions. In all the printed wisdom spread before us daily, there is no visible answer to the question, and certainly this writer will not venture an answer. Even with all the past events to guide us, no one has as yet come forward with a generally accepted reason as to why we took the nose dive which left us in our present condition. Over-production and under-consumption have both been cited, but to determine which of these could properly be blamed would require wisdom capable of telling which came first, the hen or the egg. The displacement of labor by machines has been advanced as one of the main causes and while many of us have personal knowledge of certain instances where labor forces have been largely reduced by the installation of man-saving equipment, it must not be forgotten that this same reason for unemployment and hard times has been periodically advanced from time immemorial and has just as surely been forgotten as soon as "times" improved again. Surely we have not in this particular decade of the world's history reached a point of machine saturation. The Republican administration has come in for its full share of responsibility, and naturally so, for it was the Party in power. President Hoover has not escaped either, and along with the other sins of commission and omission laid to his door by a partisan press and poorly informed citizens, he is held responsible for the situation in which our farmers of the Middle West have found themselves. And since the farmer can't buy, then the East can't sell,—and there you are, the President is the cause of it all. That's easy reasoning, but looks like poor economics when we find that other Nations are having troubles similar to our own; England with its unemployment "dole," Germany with her present menace of Fascism, Italy with her recent drastic wage reduction to all government employees, Australia with her existing widespread depression and Russia with her forced labor, all indicate economic conditions far more severe than those with which we now struggle, and should prove that no single individual could possibly be responsible for their existence in any one Country.

If we knew the underlying cause of our troubles, we would be in far better position to form some worth-while idea as to when they will be relieved. But with even that information withheld from us, our best prophecies are but little better than guesses. No doubt there will come a future time, say a few years hence, when the mists of uncertainty will have vanished from our eyes and looking backward over these last few years we will be able to understand why the present situation developed.

We will at least know its cause with as much certainty as our people of an earlier day knew why the 1896-97 depression was so severe that corn was burned for fuel in Kansas and "hoboes" swarmed the Country in search of work; or why the years of 1906-07 are still remembered as a critical period with our industries, when jobs were as scarce as the proverbial hen's tooth and money for development could not be found; or why the Wilson administration in 1913 faced an industrial depression fully as severe as the present one and was only saved from an acounting at the polls by the outbreak of the Great War with its quickening of trade channels and movement of supplies from America; or why in 1921 the country again slackened its pace while the grass and weeds grew waist-high in the yards of many of our large industrial plants and long files of freight cars and boarded-up locomotives, stretching mile after mile on unused, grass-grown sidings paid a sad and silent tribute to a mighty commerce which for the time had vanished from the rails.

Whether these ever recurring periods of business depression are due to psychological changes in our people or whether they are caused by our own awkwardness in handling our affairs may not be known, but this we do know—that in practically every case the relatively short period of "hard times," unemployment, losses and inactivity has been followed by a much longer period of activity and prosperity even greater than that which had gone before. It would seem almost as if during the periods of slackness when we are careful and economical in all our undertakings, we are able to establish a back-log of solid values from which our whole industrial and business life is then able to move forward to greater achievements. The continued growth in our population and the ever increasing needs and desires of our people create demands which nothing short of Nation-wide activity will supply. When will these needs become acute and when will this activity again appear are two questions hard to answer. Perhaps there are men sitting in key positions in the Country who are now able to hazard a pretty shrewd guess as to the time, but if so, they are hard to discover right now. Certainly the writer of this article is not one of them. He can only feel as thousands of others must feel, that, if we watch our steps carefully now and keep ourselves prepared for whatever fate may deal out to us, ultimately we are going to pull out of these hard times and then with a slight re-arrangement in the words of the popular song—"Happy Days Will Come Again."

The Art of Heating Marches On

By H. DOBRIN*

No one knows when man first discovered fire. It may be as much as 50,000 years ago. As soon as man learned how to produce heat, he was enabled

H. DOBRIN

to populate the colder climes, since it is generally thought that the birthplace of the race was in the warmer lands. It is generally thought that up to only a few centuries ago, the best fire that man was able to produce did not exceed the temperature of the ordinary coal fire.

When, less than two centuries ago, the discovery of gas was made, and man learned how to make artificial fuel, this marked a tremendous epoch in the advancement of modern civilization.

It is exactly a century ago (1830) when James Neilson discovered the use of preheated air for blast furnaces.

When Bunsen made the great discovery that, by mixing gas and air prior to ignition, it is possible to develop a higher temperature than by the use of the old luminous flame, this marked a further step in the art of heat application.

The Siemens Brothers' discovery of the regenerative furnace marked a further advance in the art of heating. Until the advent of this type of heat development, high temperatures such as are now employed in industrial heating were impossible. Today we can produce temperatures up to 9000° F. In fact, the present ability to produce high temperatures has been entirely limited by the ability of the physical apparatus and materials to withstand such temperatures.

When Auer Von Welsbach discovered the gas mantle, it enabled us to get the kind of light which illuminated the mind of mankind. Man was striding on in his march of progress. Up to then, when the sun set, he was in comparative darkness. The best

*Consulting Fuel Engineer, Pittsburgh, Pa.

he had was a candle light, and before that he burnt slivers in the fireplace.

Perhaps there was no need for light after the sun set. Most of the world was illiterate and steeped not only in physical darkness, but in mental darkness. As soon as more light and heat came to the use of man, he started to learn how to read and write. Before that, from dawn to dusk he had to dig into the earth for the sole purpose of filling his stomach. With the ability to utilize light and heat, there slowly came man's emancipation from continuous toil.

In the last forty years, great advances have been made by the human family. Men no longer have to grub in the earth from dawn to dusk to provide the bare necessities. Men use the art of heating as a handmaiden to perform their labor.

With the finding of gaseous fuel there arose great steam power plants. From a few pounds pressure we have developed to the abilities of 1000 pounds pressure. From a few horsepower we have developed to the ability of 1000 horsepower and more in a single unit. In conjunction with this steam and power making ability, rose also the electrical industry, a great giant which now moves the wheels of the world's work.

From a small, two-foot square house-heating unit, we have come to utilize gigantic furnaces fired with gaseous fuel. Industry is gradually getting away from the use of solid coal as a fuel, and recognizes that coal as such is merely a raw material for fuel. As progress marches on, the utilization of gas rather than solid coal is assuming vast proportions.

Some twenty-five years ago, a furnace doing metallurgical heating for steel heat treating was not more than 3 or 4 feet in its cubical dimensions. Today furnaces over 150 feet long are to be found in the average steel works, for heat treating or normalizing.

I had occasion a few years ago to invite the manager of a utility company serving 27,000 gas consumers, to witness the performance of a single steel heating furnace, which used more by-product gas in one day than they were selling to all of their 27,000 consumers in the same day.

Recently the use of gas fuel has been successfully applied to reverberatory copper smelting, a field where gas was always considered impracticable. This particular furnace is 140 feet long by 28 feet wide, and produces a temperature of 2750° F. by premixing air and gas in automatic proportioning mixers. Similarly, gas in unheard of proportions is being applied to cement burning. One particular furnace now uses as much as 110,000,000 B.T.U. per hour. Such tremendous quantities of heat in one heating unit could hardly be visualized in the old days. In fact, no one thought that such large burner units would ever be developed. Burners were thought of in terms of 10 or 20 cubic feet of gas capacity per hour. Today we are building burners which consume 50,000 and 100,000 cubic feet of gas per hour.

With the adoption by the steel industry of the by-product oven, tremendous quantities of artificial gas were released. All this new fuel, of which one company in the Pittsburgh district produces over 150,000,000 cubic feet per day, has been absorbed by the steel industry for steel smelting, ingot heating and other metallurgical heating processes. Steel melting furnaces of 300 tons or more to the single heat, no longer stagger our imaginations. Blast furnaces of over 1000 tons capacity are now commonplace.

Early in this century we talked of gas pressures for purposes of distribution in terms of 1/10th of an inch, and 30/10ths, which is only three inches, was at one time the limit of pressures used in the then existing text-books. Today we talk of 100 pounds and 200 pounds of gas pressures. Two hundred pounds is 5400 inches, or 1800 times the 3-inch maximum unit applied by the gas industry for ordinary measuring purposes.

Only fifteen years ago, industry generally did not avail itself of the use of heat measuring devices. The total cost then of a pyrometer was some $100. It has been my personal experience that to try and recommend the use of such a piece of apparatus took a good deal of courage. Today, thousands of dollars are specified in the original plans for heat measuring devices. They not only specify and purchase, as a matter of course, these heat measuring devices, but they provide for a dust-proof case to protect the instrument. Then they purchase an additional dust-proof case to protect the first dust-proof case. They are willing to spend more money today for the second dust-proof case than they were willing to spend in the past for the entire instrument.

The same is true of flow measurement devices. Up to only a very recent date, flow meters for the measurement of gaseous flows were looked upon with askance by the bulk of industry. I remember a case of an industrial plant in the South that was loaded up with sufficient volumetric meters to amount to a small fortune. One flow meter, at a very nominal cost, would have measured as effectively the entire volume of gas which this plant was using. It took a good deal of time and persuasion to make industry realize the effectiveness and accuracy of flow measuring devices. This has immeasureably advanced the accounting ability in the handling of tremendous volumes of gas and steam and other liquid and gaseous materials used in industry.

Ever since the inception of the steel industry, one type of application was the common practice in melting steel. Today the bulk of the industry is turning to instruments for the control of all the factors that enter into fuel burning in the open hearth furnace. This means controls for ratios of air and gas, pressures and drafts.

We are also learning how to conserve fuel by insulation of furnaces against heat leakage, and by devices for the recovery of heat in waste gases.

The rise of our vast industrial civilization can be traced directly to our ability to produce temperatures. In fact, the history of the growth of our industrial civilization is parallel to the history of our advancement in the art of heat application. There is, therefore, nothing strange in the fact that the progress of any nation is entirely measured by its ability to extract fuels from the earth—so much so, that if we take statistical data, we will find that the rank of importance of the world's nations is entirely measured by their total annual production of fuels in the form of coal, gas or oil; not how much they have locked up and unexploited, but the extent to which they have utilized and developed their natural fuel resources.

Cost Records

By R. F. SANNER*

The beginning of a new year should find everyone with a definite program, and a desire to accomplish as nearly 100% as possible, everything on this program. The reduction of maintenance costs has, in all probability, been included in the program of every department superintendent. The mere fact that this item has been included, does not make possible any savings. Savings which are really worth while can be effected only after an exhaustive study of maintenance costs, and are dependent on the amount of maintenance cost data which is available in the desired form.

It is true that every manufacturing organization has a cost accounting department, but in the majority of steel plants, their work is of such a broad scope, that the data which they have collected probably is

R. F. Sanner

of very little value to the superintendent of a maintenance department in determining any specific weaknesses. If you were to review the charge accounts for material and labor in repairs, which the accounting department uses for any mill or other such department in a plant, it would probably be found that the equipment in a rolling department would be classified for accounting purposes somewhat as follows:

Engines and connections.
Charging and drawing machinery.
Roll trains and tables.
Shears, shear tables and guides.
Scrap conveyors and connections.
Cranes and connections except charging and drawing cranes.
Cooling beds.
All other machinery.

The total expenditures for repairs is then obtained by totalling the expenditures for each of the above items. This is probably sufficient for an accounting department, but it is not sufficient for study by the maintenance departments. It might be asked, what part of the expenditure for each of the above items was for electrical department repairs, and what part for mechanical department repairs. Even though the electrical and mechanical expenditures were reported separately, it would not begin to adequately fulfill the requirements of an accounting system whose records would be of any assistance in the reduction of maintenance costs. Any or all of the above mentioned items may include two or more pieces of equipment, and each piece of equipment is frequently capable of being further subdivided. Consequently, any departmental superintendent attempting to utilize such cost data, would find it an impossibility. It seems evident then, that from the viewpoint of an electrical superintendent or engineer, it is essential that any maintenance cost records, which are to be studied for the purpose of reducing maintenance costs, should be obtained and recorded with this point in mind. The details of such a system should therefore be determined by the individual department superintendents.

There probably has been inaugurated at some time or another, systems of recording maintenance costs, which have failed because the data obtained was not sufficiently detailed for determining accurately the part of the equipment which was costly to maintain. Any piece of equipment may not be costly to maintain as a whole, but there may be some part of this piece of equipment which requires costly maintenance, and offers the possibility of large savings if this maintenance can be eliminated. A well designed system of cost records would make it possible to easily detect this particular part.

There may be some question as to the best system to be employed for recording maintenance cost data, the detail with which the data should be recorded, and the best means for obtaining the information. To undertake the inauguration of a system of recording maintenance cost data, which will be of any consequential value, may, in some cases, require additions to the clerical force. However, any additional expenditures for overhead can only be justified by the reductions in maintenance costs which are possible as the result of the installation of such a cost recording system. For this reason, it is essential to carefully plan what is to be done and to minimize any additional expense.

In addition to the savings which are possible because of the ease in detecting equipment which is requiring high maintenance, a system of recording maintenance costs can be so designed as to make possible the following:

1. Comparisons of motor, control, and mechanical maintenance of similar equipment.
2. Comparison of motors and controls of different manufacture.
3. Effect of the duty cycle on maintenance costs.
4. Accurate estimating of maintenance savings on proposed new equipment.

It must be remembered, that in order to have an accurate system of recording maintenance costs, it requires co-operation on the part of every person

* Assistant to the Electrical Engineer, Carnegie Steel Company, Duquesne, Pa.

in the department, not only the clerical force recording the data, and that the data so recorded is of no value unless it is accurate.

Finally, any data collected is not of much consequence, unless it is intelligently studied and tabulated in graphic form, by someone who has had sufficient technical training to make the necessary comparisons and recommendations for improvements.

Developments in Products at Lukens Steel Company

By J. H. McELHINNEY*

Rolled steel plates, primary product of Lukens, are rolled on five mills in the Lukens plant. First, in order of size, is the 48-inch Universal mill; next is the 84-inch four-high sheared plate mill, the 112-inch three-high sheared plate mill, and the 140-inch three-high sheared plate mill. Largest of all is the 206-inch sheared plate mill, the largest plate rolling mill in the world. It is of the four-high reversing type, with two 34-inch diameter by 206-inch working face operating rolls of chilled iron, and two 50-inch diameter backing rolls of cast steel. The operating rolls weigh approximately 40 tons each, while the backing rolls are about 60 tons each in weight.

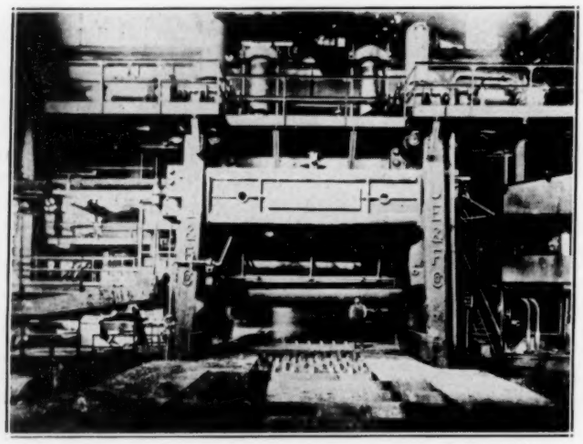

FIG. 1. 206" Mill.

While the 206-inch mill is the source of the plates for the larger rolled products of Lukens with which every plate consumer is more or less familiar, the smaller mills produce a variety of less spectacular, but no less interesting, rolled steel products. On the 48-inch Universal mill, plates from 8 inches up to 48 inches in width are produced. On the sheared plate mills, lightest size produced, ordinarily, is #10 B. W. G. by any width, up to 72 inches. At the other extreme, on the large 206-inch mill, plates can be rolled, by special arrangement, up to 195 inches in width in the lighter gauges. Further, on this mill Lukens regularly rolls plates from 40-inch ingots weighing about 90,000 pounds, and, when necessary, plates in the heavier thicknesses up to 12 inches and 14 inches.

As plates above 2 inches thick do not shear satisfactorily such gauges have required the establishment of a considerable department for trimming with gas. This requires machine cutting of all imaginable patterns and shapes and is a most interesting development. For exhibition purposes thicknesses up to 24 inches have been cut.

Lukens produces every quality of plate to meet the varying needs of consumers. These qualities include tank steel, pressing steel (not flange steel for boiler construction), flange or boiler steel, ordinary firebox steel, locomotive firebox steel (both basic and acid), still bottom steel, marine steel, Naval specifications steel, hull plates to specifications, extra soft boiler steel, welding quality steel, copper-bearing steels, 2 per cent nickel steels in boiler and firebox quality, and chrome-vanadium and other alloy steel plates.

A recent and most interesting development in rolled steel products is the Lukens nickel clad plate, in which a thin layer of pure nickel is rolled on to the surface of a carbon steel plate of the required thickness. While this product is still in state of development, nickel clad plate is expected to be of considerable value in applications requiring resistance to the attack of caustic soda and other destructive elements.

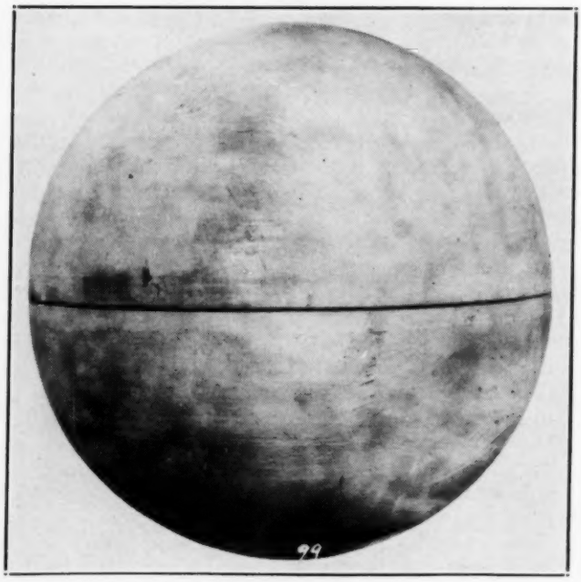

FIG. 2. Helium Ball. 2-94" diameter x 2" thick material layed together to form a sphere.

Lukens also rolls, on a conversion basis, a variety of special metals in plate sizes, in co-operation with patentees or licensees controlling or handling the

* General Supt., Lukens Steel Co., Coatesville, Pa.

sales privileges for the finished plates. Among these special metals are plates of aluminum, chrome iron, chrome nickel, pure copper, pure nickel, wrought iron, Monel, aluminum, Everdur, Krupp Nirosta, Misco "C", and Timang. For these products suitable annealing, sand blasting and pickling equipment is available.

Closely allied with the rolling of plates is the flanging and dishing of pressure-vessel heads and the pressing of various shapes. The Lukens Flanging Department, which operates for service of fabricators of steel construction, is in regular production on heads of all sizes, from the smallest to the largest, and also fulfills varying requirements for the pressing of shapes, many of which are of most intricate design.

The Flanging Department equipment includes a large spinning machine, with capacity to handle blanks up to 202 inches in diameter, and a smaller spinning machine for heads up to 60 inches in diameter. In pressing heavy gauge heads and shapes, two four-post hydraulic presses, of 1,000-ton and 1,500-ton capacity, are used. For bending, straightening and flue work, two 200-ton sectional flanging presses are employed. Each of the presses is served by an oil-fired furnace, with pyrometer control for the processing of alloy steels.

The Lukens Flanging Department was the first to produce large elliptical spun and pressed heads for pressure vessels. This type of head, with the major axis of the ellipsoid twice the minor axis, will theoretically withstand as much pressure as the cylindrical shell of identical gauge. Such spun and pressed heads are widely employed in cracking stills in petroleum refineries, and are also rapidly becoming the preference for all types of pressure work.

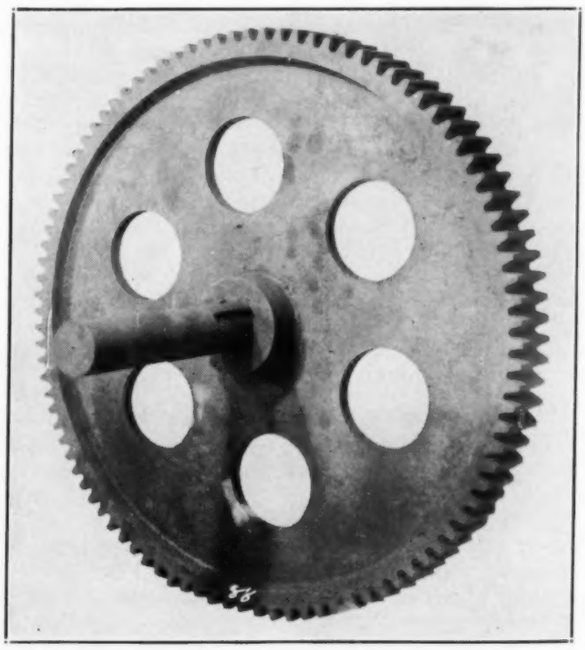

FIG. 3. Gear Wheel.

Other products of the Lukens Flanging Department, in addition to heads for various purposes, are flued openings, saddles, steam domes, manhole covers, handhole covers, braces, expansion joints, concrete pipe forms, ship fenders (for marine floating equipment, docks and piers), heavy brake drums, channel shapes, large annealing pots, mixing bowls, smelting pots, and coal chutes.

As is the case with all steel mill organizations, Lukens in the last few years advanced considerably in doing repair work by electric and gas welding. However, the combination of the extra heavy plates available, machine gas cutting, a heavy pressing or forming department and experience making steel for heavy welded pressure vessels contributed to the building up by welding of heavier replacement parts than would seem economical at most plants.

Lukens has, for example, produced soaking pit covers of rolled steel plate, gas cut to size and shape, and then welded into the complete unit. Welded soaking pit covers weigh less, thus facilitating handling, and cost considerably less. Charging boxes made in welded steel construction have also been made and offer a worth-while economy in cost. Charging car tops, ingot car decks, ladle stands, shear housings and other parts, table rollers and girders for the 206-inch mill, flywheels, as well as a host of other parts or equipment, have been produced in welded steel more economically and in less time, and have been found to render dependable and continuous service.

A few years ago, Lukens began experiments in the redesign of various parts of machinery built by some of its customers, with a view to adaptation of the parts to manufacture in welded steel construction. The results were so satisfactory that, in order to meet the constantly increasing demand for welded steel construction in machinery parts, Lukens found it necessary to form a subsidiary company, Lukenweld, Incorporated. This subsidiary is engaged exclusively in the fabrication, by means of gas cutting, pressing and welding, of machinery parts and equipment for all industry. The product is marketed under the name, Lukenweld Construction.

The extent of this activity, and the wide industrial utilization of Lukenweld Construction at the present time, are far too broad to fall within the scope of this article. Sufficient it is, perhaps, to say that the Lukenweld plant has the most modern equipment required for the work, and occupies approximately 25,000 square feet of floor space for assembly and welding. Trained operators, familiar with this type of welding, which is in accordance with insurance welding practice, work under rigid procedure control and inspection.

In the manufacture of Lukenweld Construction, plates of rolled steel are gas cut or machined to blue print templates, (no patterns of any kind are required) and then, if required, are bent to shape, after which they are sent to the welding department. The plates are then assembled by welding.

Since the success of welded steel construction is pre-eminently a matter of employment of the proper design, the Lukenweld organization has established a Research and Development Division, and one of its functions is to co-operate with the designers of the machinery builder, and assist them in obtaining proper and dependable designs.

At the present time, the Lukenweld organization is privileged to supply other steel plants and rolling mills with charging boxes, soaking pit covers and

other parts and equipment in Lukenweld Construction. In addition, Lukenweld Construction is used by many manufacturers of heavy machinery and equipment for various parts, because of its higher rigidity, strength, and endurance, lower weight, as well as speed in delivery.

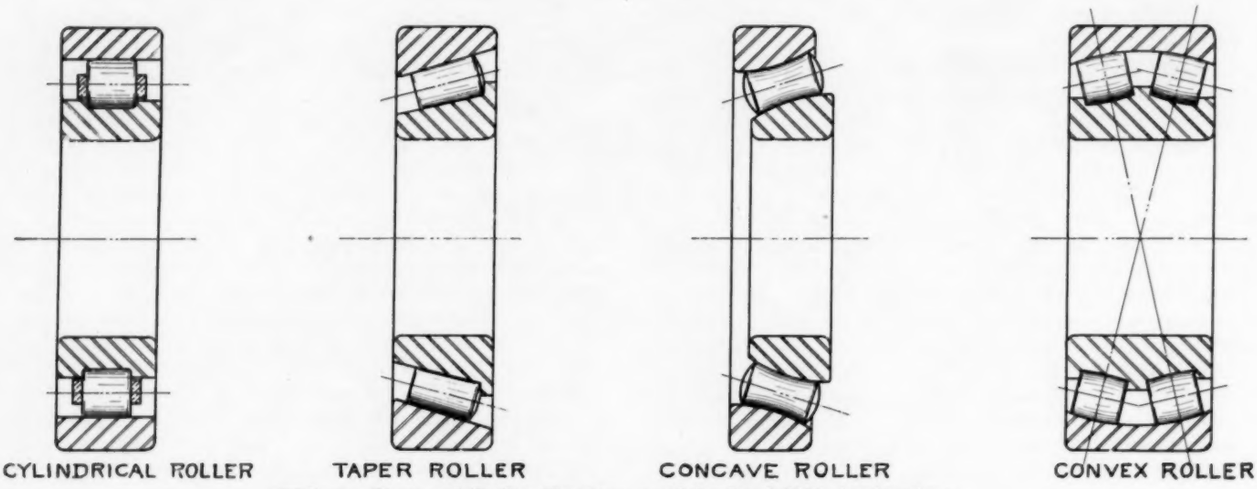

FIG. 1. Types of Roller Bearings used in Steel Mill Applications.

The Lubrication of Ball and Roller Bearings in the Steel Mill

By D. E. BATESOLE*

The rapidly growing use of anti-friction bearings in the steel mill and particularly the introduction of such bearings in new and hitherto untried fields of application, has made the problem of bearing lubrication a most important one. Regardless of the type or size, ball and roller bearings must be assured of adequate and continuous lubrication if successful results are to be realized.

Perhaps in no other field are the conditions of bearing operation so diversified as in the various applications found in the steel mill of today. In some instances tremendous loads have to be sustained, as for example on roll necks, while in other equipment high speeds are encountered. Extremes of temperature are often found, ranging from zero or lower in exposed units during the winter months, up to 400° to 500° F. or even higher. Furthermore, bearings are often mounted on vertical as well as horizontal shafts, thereby calling for considerable study as to ways and means of supplying and retaining the lubricant.

Lubrication of ball and roller bearings is necessary for the following reasons: (1) To reduce the friction between separator and rolling elements, or between these rolling elements themselves if no separator is used; (2) To reduce the friction between the rolling elements and their raceways where true rolling does not take place; (3) To protect the highly finished surfaces of the balls or rollers and their raceways; (4) As a secondary function to sometimes assist in the protection of the bearing housings against the ingress of foreign matter; and (5) In some cases, to conduct heat away from the bearings and housings.

In general it may be stated that the requirements for the lubrication of roller bearings do not differ materially from those required for ball bearings. When operating at relatively high speed, roller bearings will cause greater agitation of the lubricant so that, conditions being the same, roller bearings require a lubricant of somewhat lighter consistency than ball bearings. Likewise for an equal temperature rise, the level of the lubricant in a roller bearing housing should be lower than that used in a ball bearing application. Roller bearings having outer raceways which are not parallel to the axes of the bearing bore (see Fig. 1) also have a pumping effect, where oil is used, tending to force the oil toward the high side of the raceway. Grease likewise has a tendency at times to collect at the high side of bearings with tapered raceways.

Should Grease or Oil be Used for Lubrication?

The relative merits of grease versus oil as a bearing lubricant have been a source of argument almost from the advent of the anti-friction bearing. In most cases the manufacturer installing bearings in new equipment is free to choose either lubricant. He is only restricted by (1) unusual temperature conditions, either very high or very low, or (2) by the design of the housings to retain oil. Occasionally the question of speed may effect his choice, although it has been found that grease of the proper qualifications and applied in the right manner will take care of unusually high operating speeds.

In general, it is agreed that grease lubrication is less expensive than oil. Housings, with the neces-

*Assistant Engineering Manager, Norma-Hoffmann Bearings Corporation, Stamford, Conn.

sary slingers, etc., to retain oil, are usually quite costly. Furthermore, due to vaporization, it is necessary to renew the supply of oil at more frequent intervals. Briefly, the advantages claimed for oil lubrication are as follows:

1. Oil when applied to bearing housings is apt to be more clean than grease, since it is usually kept in closed containers.
2. Devices can be applied by means of which it is possible to determine at any time the quantity of oil in the bearing housing.
3. Overflow openings can be provided to insure that the lubricant level will not be exceeded.
4. A sump or reservoir can and generally is used so that grit and dirty particles may collect below the bearings; with grease lubrication, such particles usually remain in suspension.
5. Old oil can be very easily drained and washed from housings and a new supply added.
6. Oil lubrication will take care of extremely low temperatures, and can be circulated if necessary through cooling coils for applications subjected to abnormally high temperatures.

The advantages of grease lubrication may be listed as follows:

1. Grease is more easily retained in bearing housings than oil.
2. For slow speeds, grease may be applied with a pressure gun—a very clean method.
3. Grease tends to fill the space between shaft and housing, thereby assisting in keeping out dirt.
4. Grease does not need replacement as frequently as oil, as it does not volatilize as readily.
5. Grease usually remains in the bearing when idle, whereas oil may settle to the bottom of the housings, leaving some parts of the bearing entirely devoid of lubricant and exposed to rust.

Requirements for a Good Bearing Lubricant

One of the most important requirements for a good lubricant is that it shall be free from acid or free from ingredients which might form acids. Mineral oils only should be used, as vegetable or animal oils are apt to be unstable and liable to develop free acid. Lubricants should also have an unusually low free alkali and moisture content for the same reason, namely to prevent corrosion.

Greases should not contain mechanical fillers such as talc, graphite, pumice or other stiffening or body making materials which may tend to separate from the lubricant and become lodged between the balls or rollers and the retainer so as to cause binding. Greases may be of the sodium or calcium base. Sodium soap greases are preferred except where moisture is apt to be present. Calcium greases are apt to be unaffected by moisture but they have a low melting point, whereas sodium soap greases of a fibrous nature will withstand temperatures up to 300° F. For very low temperature, a light bodied oil of a low cold test should be used.

A rather good general lubricant specification called for by one large user of ball and roller bearings is as follows:

Free acid	Nil
Free alkali	0.1%
Sulphur	.03%
Resin	Nil
Neutral Saponifiable oil	1.00%
Ash	1.5%
Moisture	2.0%
Abrasive particles	Nil

In addition to the chemical and physical characteristics of a grease, the matter of proper consistency or viscosity is quite important. The churning effect on the lubricant is largely a factor of the bearing retainer speed. In most applications the shaft is in rotation and the cage speed may be approximately one-third of the shaft speed, but when the bearing outer ring is in rotation, the cage speed

LUBRICATION OF BALL AND CYLINDRICAL ROLLER BEARINGS

Bearing Bore (Millimeters)	Speed of Shaft in R.P.M.						
	Up to 500 R.P.M.	500-1000	1000-1500	1500-3000	3000-5000	5000-10000	Above 10000
25 to 35	Heavy Grease	Medium Grease	Medium Grease	Light Grease	Light Grease	Very Light Grease	Oil
40 to 65	Heavy Grease	Medium Grease	Medium Grease	Light Grease	Very Light Grease		
70 to 100	Heavy Grease	Medium Grease	Light Grease	Very Light Grease			
100 to 130	Heavy Grease	Medium Grease	Light Grease				
Over 130	Medium Grease	Light Grease					

NOTE:—Oil may be used at any of the above speeds if housings are designed to retain the oil. The proper consistency of oil should be selected for the speed, lighter oils being used at higher speeds.

FIG. 2. Table of Recommended Lubricants for Ball and Cylindrical Roller Bearings.

may be almost doubled, and the churning effect therefore much greater.

As a general guide, the table below may be found useful. It is assumed in making the table that there are no unusual conditions of high and low temperatures and that bearings of the medium or 300 series are used, this series having been standardized upon the A. I. & S. E. E.

How Often Should Bearings Be Lubricated?

It will be recalled from the questionnaire sent out by the A. I. & S. E. E. Special Committee on Bearings in 1929 that replies to the question as to how often bearings on steel mill motors should be lubricated, showed a great difference of opinion. Some users called for lubrication only once per year, others as often as once each week. The same difference of opinion exists in connection with other bearing mountings than mill motors.

In general it may be stated that anti-friction bearings, if used with properly designed housings, and assuming no unusual temperature conditions, should not require lubrication more often than every three months. The best practice on new applications is to check the housings after one week of operation. If the lubricant seems to be unchanged both in regard to quantity and appearance, the period before further examination is required, should be extended in gradually lengthening intervals until the proper lubricating schedule is arrived at.

Method of Lubricating Ball and Roller Bearings

The most popular method for adding lubricant to bearing housings in the steel mill is by means of the pressure gun. This system suffices for the large majority of the applications since they are of relatively slow speed. Where speeds are high, pressure lubrication is not recommended as the housings become choked with grease, with the result that overheating occurs through the agitation of the lubricant itself. A circulating or splash system using oil is of course suitable for higher speed, but where grease is used it is best to remove the housing cover carefully and add just the proper amount. If the grease has remained in the housings for a long time, it may be desirable to remove this old grease before adding the new supply. However, unless extreme care can be used in this operation to see that no grit or dirt enters, it is better to leave the old grease in the housings, assuming of course, that the old grease is still in a fair condition.

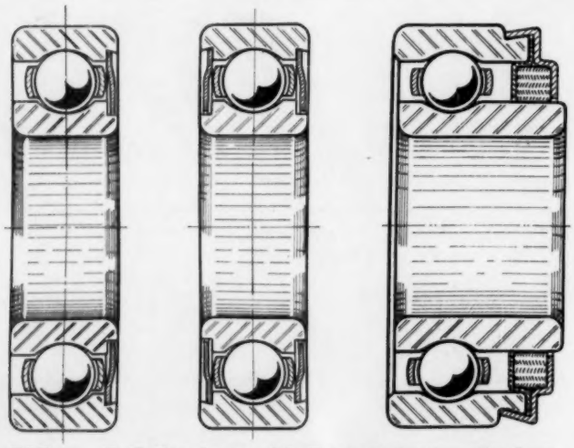

FIG. 3. Ball Bearings with Typical Sealing Devices.

A very small amount of lubricant suffices for average bearing operation, particularly if the material meets the specifications previously outlined. The oft repeated rule is to have the oil level not higher than the middle of the lowermost ball or roller. Where grease is used, the free space in the housing should never be filled more than one-third full, except at very low bearing speed. For unusually high speed, the rolling elements should not splash into the oil, but instead slingers should be arranged to pass through the oil and throw it into the bearings in the form of a spray, or again a wick oiling or drop feed system may be used.

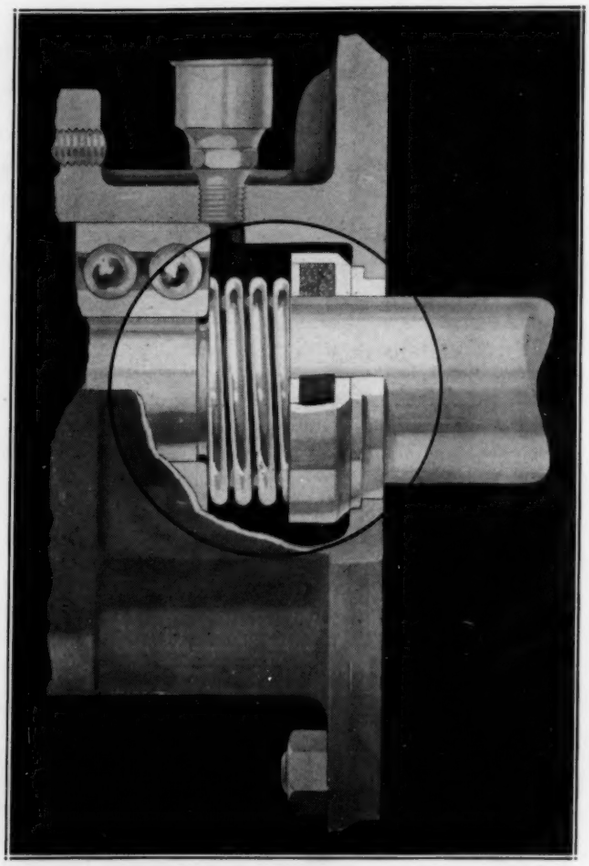

FIG. 4. Spring Adjusted Sealing Device (Courtesy of Cooke Seal Ring—Chicago).

Sealing Devices for Bearings and Housings

The cost of applying adequate protecting means for bearing housings has often proved to be a serious objection to their use. To reduce this cost various types of sealing devices have been developed in the past few years. Bearing manufacturers have incorporated seals of various kinds in the bearings themselves, as will be observed in Fig. 3. The plate type seals shown at the left are quite effective under average conditions although where there is apt to be considerable dirt and dust present, a secondary protective means of some kind is desirable. Another device known as the felt seal is shown at the right. It consists of a felt washer held between two pressed

steel plates, the outer of which is fastened to the outer ring of the bearing. At the present time these felt seal bearings are made in the smaller sizes only.

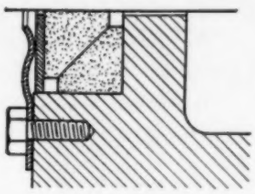

FIG. 5. Spring Adjusted Cork Seals (Courtesy of Armstrong Cork Co.).

A variety of sealing devices for bearing housings have been put on the market during the past few years. They greatly reduce the total cost of bearing mounting as they are easily applied and are quite effective not only in retaining the lubricant, but also in keeping out foreign matter. Some of these seals are made of cork and similar materials, others employ leather in various forms.

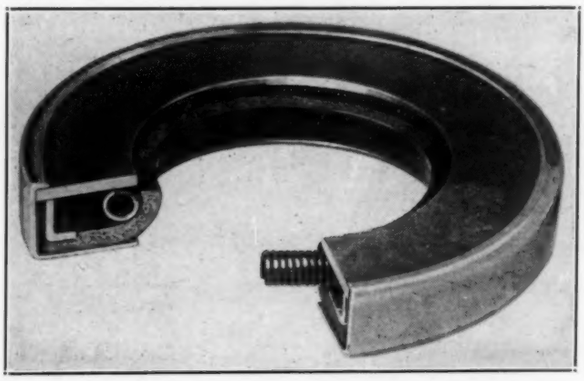

FIG. 6. Leather Seal Adjusted by Spiral Spring (Coutesy of Chicago Rawhide Mfg. Co.).

The illustration in Fig. 4 shows a spring adjusted seal using a packing material which is compressed by the spring and held in contact with the shaft. Another seal using triangular sectioned cork rings is shown in Fig. 5. Here again spring pressure is used to obtain a good contact of the cork rings with the shaft.

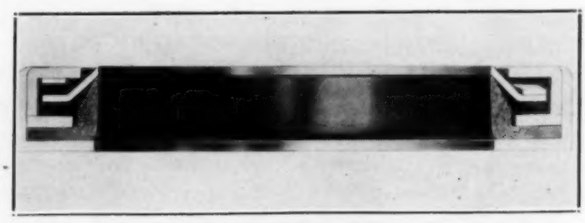

FIG. 7. Leather Seal with Corrugated Spring Adjustment (Courtesy of Gits Bros. Mfg. Co.).

Several types of cupped leather seals are shown in section in Figs. 6 and 7. It will be observed that the leather is pressed inwardly against the shaft by means of a coiled spring in one case and by a corrugated spring and tapered washer in the other. These seals are available in a number of standard

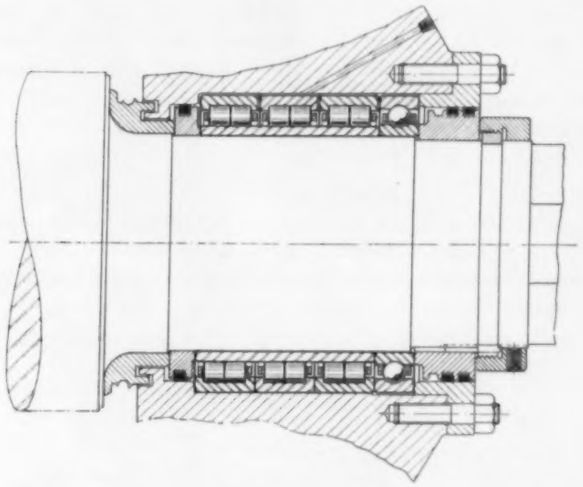

FIG. 8. Piston Ring Seal on Roll Neck Mounting.

sizes. They may be quickly and easily pressed into recesses bored for them in the bearing housing cover plates.

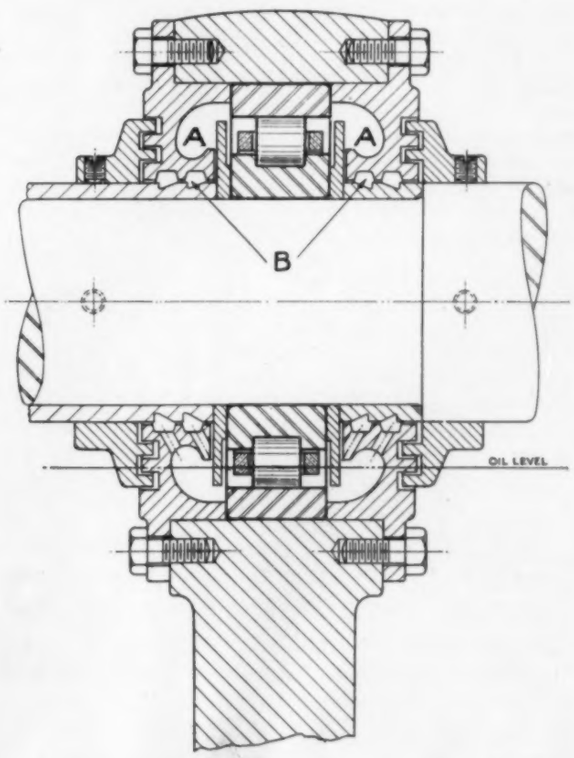

FIG. 9. Oil Slinger and Housing Construction for Retaining Oil.

Methods of Sealing Against Oil Leakage

In general, it is not found difficult to retain grease lubricant in bearing housings, but the problem of preventing oil leakage is sometimes more difficult. Felt washers are effective for a time if of good quality and of the correct size, but they will wear away sooner or later and have to be replaced. Facilities should be provided therefore so that the felt can be quickly and easily replaced when found necessary. As a general rule felts should not be used where the peripheral speed of the rotating surface in contact exceeds 1500 feet per minute.

Oil sealing rings similar to piston rings have also been found very effective, especially on fairly large applications using a heavy oil. A typical piston ring seal is shown in the roll neck application (Fig. 8). Some designers prefer to use two or more rings as an added insurance against oil leakage. The housing bore should have a slight taper at the end where the rings are inserted with the rotating member to permit of easier assembly.

Another housing design to prevent oil leakage is that shown in Fig. 9. This arrangement is suitable for speeds exceeding 100 R.P.M. and is particularly effective at higher speed. A slinger is located at the outer side of the bearing, and as this slinger throws off the oil, it impinges against the inner surface of the housing and is caught in the grooved channel at "A". The oil then drains downward and into the lower part of the housing. Supplementary oil grooves may be used as shown at "B", these being so arranged that any oil collecting in them will drain back into the oil sump.

Sometimes it is desirable or necessary to use a circulating oiling system with the lubricating oil passing through cooling coils to keep the temperature of the bearings as low as possible. A circulating system is used on the hot saw shown in Fig. 10. The lubricant enters the self-aligning housings at the top and after circulating through the bearings, passes out through the piping connections at the bottom. This method of oiling has the advantage that there is no excessive churning of the oil causing a vapor, and therefore very little oil will escape in this form from the housings.

The lubrication of roll neck bearing mountings has naturally received its share of attention during the recent development of anti-friction applications for various types of mills. There seems to be a wide difference of opinion among mill designers and users as to the best type of lubrication. One mill manufacturer has experimented with lubricants ranging from heavy cup grease to medium bodied oil, finding them all satisfactory for the average roll neck application. It would appear therefore that each roll neck design may call for individual consideration to obtain the best results.

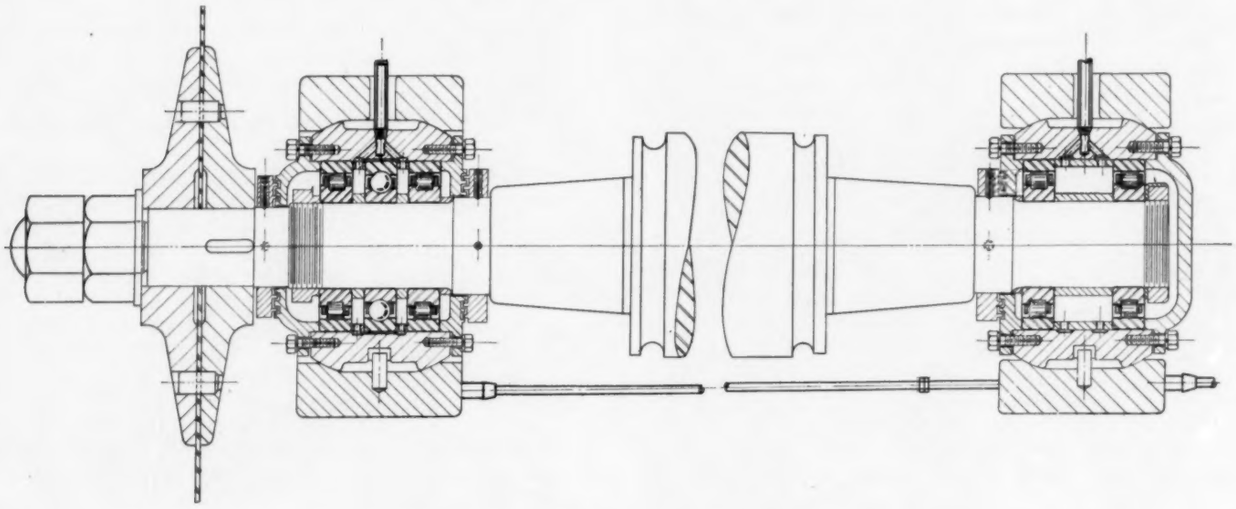

FIG. 10. Circulating Oil System for Hot Saw Mounting.

Obviously it is impossible to cover all of the various phases of steel mill bearing lubrication in an article of this length. An attempt has been made to outline the general requirements for suitable lubricants and also to describe various methods of applying these lubricants. Where unusual operating conditions exist, it is recommended that full details of the problem be submitted to the bearing manufacturers for their suggestions. It is to be noted that in recent years many of the larger oil and grease manufacturers maintain a staff of engineers whose services are available for the solution of bearing lubricating problems. This co-operation has helped materially in the successful application of anti-friction bearings.

Developments in the Application of Control Apparatus to the Iron and Steel Industry During the Year 1930

By P. B. HARWOOD*

Process Timer

The process timing device shown in the photograph was built for use in connection with the heat treating of railroad rails. There are two parts to

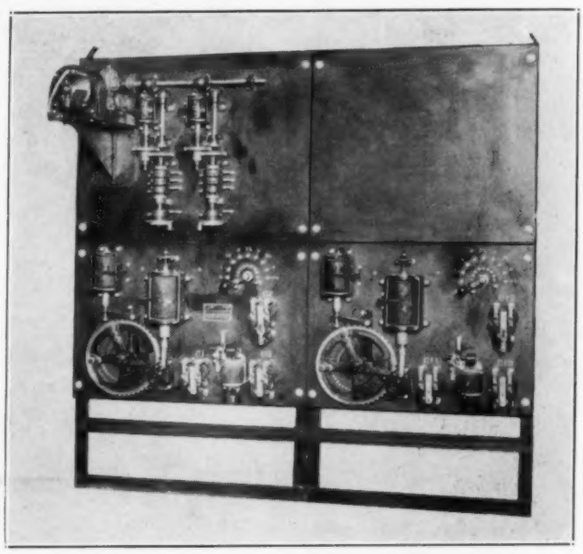

FIG. 1. Timing Control Panel.

the process—either of which may vary in time from one second to five minutes and the equipment was arranged so that at a later date a third interval could be added. The device consists of a synchronous motor driving a line shaft from which timing cylinders are operated through clutches. These timing cylinders are arranged to make one revolution in 30 seconds and they have an adjustable contact which can be arranged to close a circuit in any number of seconds up to 30. Each complete revolution of the timing cylinder energizes a ratchet operated device which moves up one notch thus measuring ½ minute. The desired number of half minutes are selected on one selector switch and the number of additional seconds on another selector switch. When the entire time has elapsed, the timing cylinder and the ratchet device each close a contact. These contacts are in series and when they are both closed a signal is operated for a certain period of time. At the same instant, the second timing mechanism is connected to the continuous running shaft by means of the clutch, and the timing of the second part of the process begins. At the end of that period the first device is again started. In this way, absolutely accurate timing in intervals varying from one second to five minutes obtained.

*Elec. Engineer, Cutler-Hammer, Inc., Milwaukee, Wis.

Large Ladle Cranes

Three complete equipments were built for 275-ton ladle cranes which are the largest ladle cranes in the world. The main hoist consists of two 200 HP. series wound motors and in addition there are 135 HP. auxiliary hoist motor and a 100 HP. auxiliary hoist motor. The main trolley is driven by a 45 HP. motor and the auxiliary trolley by a 33 HP. motor. The bridge is driven by two 200 HP. motors. The control is arranged so that in emergency the main hoist may be operated by either one of the motors alone.

Bloom Turning Equipment

Although bloom turning machines are not new, one which was developed this last year had some interesting features. The hoist was driven by a 75 HP. motor and the turning motion by a 35 HP. motor. Operation was entirely automatic. The operator simply moved his master to the "run" position when the hoist raised the billet the required distance and then stopped. At the same time the turning motion automatically started and rotated the bloom 90 degrees. As soon as the turning motion stopped, the hoist motion again started and lowered the billet on to the delivery table. When the operator moved his master to the opposite direction the reverse cycle took place. One interesting feature of this installation was that dynamic lowering was obtained whenever the billet was being lowered. Another interesting feature was that the limit switches which automatically stopped the hoist in the lower direction were set at different points. The amount of travel in the lower direction with a loaded machine being only about 1/3 of what it was in the return direction when the machine was empty.

Plate Planers

Several installations were made of very large plate edge planing machines—some of these were driven by one 200 HP. motor and others by two 125 HP. motors. These planers would accommodate a plate 50 feet long and the overall length of the machine was 74 feet. The two driving screws were mounted on opposite sides of the planer bed; each of them drove a separate carriage which was used to carry the cutting tool for trimming the edge of the plate. The motors were controlled from push-buttons mounted at both ends of the planer and also on the carriage which was designed to permit an operator to ride on it.

Magnetic Roll Controllers

Some installations were made of control for magnetic rolls which are used for conveying pipes between the various machines used in the forming process. One such installation included a total of 97 control panels used with 56-5 HP. motors and 41

3 HP. motors. These motors were arranged to be controlled in groups of from 1 to 12 from a single master and also arranged so that any one of the individual motors or controllers could be disconnected by opening its main knife switch without interfering with the operation of the other equipment. The controllers were arranged to energize the magnetic rolls at the instant of starting and to maintain this magnetic circuit during the magnetic braking period and until the motor had stopped. The field rheostats for changing the speeds of the motors were arranged so that all of them, in any one group, were varied from a single handle. This required a very specially constructed arrangement of rheostats so as to keep the space down to a minimum.

96" Plate Mills

Complete automatic variable voltage control for a 96" plate mill was built but at the time of this writing had not been installed. There is a 4000 HP. roughing mill, a 600 HP. scale breaker and then a set of finishing stands consisting of six 3500 HP. motors. The roughing mill and the scale breaker are driven by alternating current motors and the finishing stands by direct current motors using a variable voltage control scheme. The two 600 HP. edger motors are also direct current. The starting and acceleration of this entire equipment is automatic being accomplished by the use of a start and stop push-button station. There are additional push-buttons controlling motor driven field rheostats for obtaining speed variation. The equipment is arranged so that either one of two generators may be used, or they may both be used. An automatic paralleling feature is included which insures that two breakers cannot be connected to the bus, unless both are at the proper voltage and the same voltage.

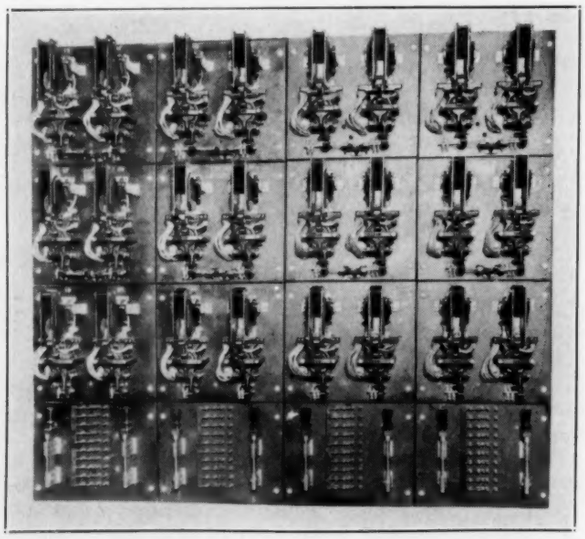

FIG. 2. Slab Rolling Mill Controller for 4-250 H.P., 230 Volts Motors.

Slab Rolling Mills

Control for four 250 HP., 230-volt motors driving a high speed slab rolling mill was installed. This control is shown on photographs attached. The motors used on this mill are especially built for high speed acceleration, and they are brought up to speed with the use of only a single step of starting resistance. The control is so arranged that first one motor and then another is connected to the line through the resistance and after the fourth one has been so connected the resistance is cut out of circuit in the first motor and then the second, and so on until they are all on the line without resistance. When the operator moves his master to the reverse position the motor stops by means of dynamic braking and then started up again in the sequence outlined above. This is done in order to keep down the current peaks on the generating equipment. Contactors especially arranged for rapid opening and closing were used on this controller and there are no current relays or time delay devices used.

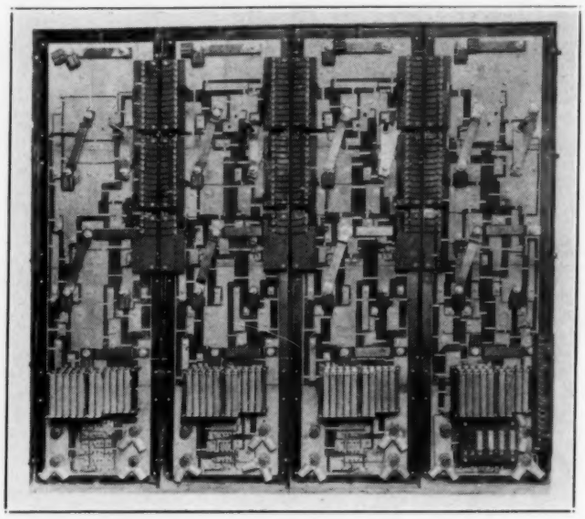

FIG. 3. Slab Rolling Mill Controller for 4-250 H.P., 230 Volts Motors.

Impulse Type Screw-Down Control

Several installations were made of screw-down equipment of the impulse type—that is, so arranged that when the operator pressed the button current was applied to the motor for a predetermined time and in a predetermined amount. Both the amount of current and the duration of its application were adjustable. By this means the screw-down motor could be arranged to run for only a definite part of a revolution so that very fine adjustment of the screw was possible.

In addition to the special applications outlined above, detail improvements in many devices were made. The carrying capacity and life of mill type contactors was very greatly increased by a number of detail improvements. Enclosing cases of a simpler design and a better appearance were developed and the use of welding for such apparatus was very greatly increased. Improvements in such devices as master switches and limit switches were also made with a view to increased accessibility and ease of adjustment.

Air Filtration as Applied to the Steel Industry

By M. R. ROBINSON*

Air Conditioning, of which air filtration constitutes a most vital and extremely important phase, is fast becoming one of America's great industries. Through the application of air conditioning, many industries such as textiles, tobacco, rayon, printing, lithographing, pharmaceutical, meat packing, cellulose and innumerable others, have been able to materially reduce losses and increase the quality of their product by controlling and maintaining a uniform condition of air movement. Just as these industries have found air conditioning profitable when applied to the manufacture of their products, so also have the owners of hotels, clubs, theaters, restaurants, railroad Pullman and dining cars and office buildings, realized its immense possibilities and are rapidly adopting air conditioning as a means of insuring the comfort of their patrons and maximum and definite financial returns on their investment. In the theater, hotel, club and restaurant the added comfort and cleanliness insures a well filled house and satisfied customers. In the office building such comfort and cleanliness attracts tenants, reduces removals to other more attractive buildings and increases the efficiency of all employees. In drafting rooms, printing establishments, and libraries, it protects drawings, paper, books, lithography; and again improves the efficiency of the employee. In the steel mill drafting room, it is of vital importance from the standpoint of improving the efficiency of the men, reducing lost time by protecting their health and safeguarding valuable drawings and tracings. It is not an unreasonable statement, therefore, to predict that within the next decade, practically every phase of industry will be better served through the aid of air conditioning.

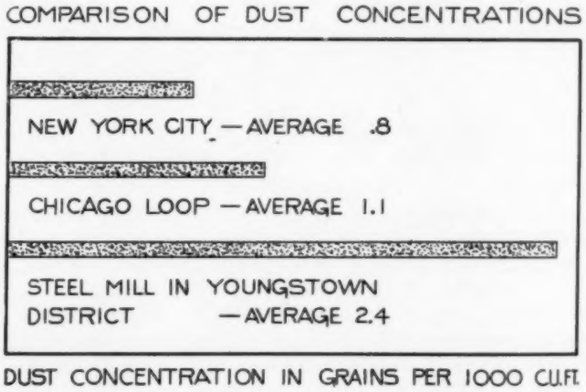
COMPARISON OF DUST CONCENTRATIONS
NEW YORK CITY — AVERAGE .8
CHICAGO LOOP — AVERAGE 1.1
STEEL MILL IN YOUNGSTOWN DISTRICT — AVERAGE 2.4
DUST CONCENTRATION IN GRAINS PER 1000 CU.FT.

FIG. 1.

To satisfactorily accomplish these results, however, it is necessary to first clean the air and then control its temperature and relative humidity either humidifying or dehumidifying as the requirements may be. It might be said, therefore, that the success of an air conditioning system depends primarily upon air filtration, as practically all foreign material must be removed from the air before forcing it into the system, since without filters, many of the dirt particles would pass through the air washer and contaminate the product, affect the health of the employee, collect in the ducts and otherwise become objectionable. Air filtration, therefore, becomes an intimate part of air conditioning and finds an important field to serve in the protection of expensive electrical equipment in the Steel Industry.

Great strides have been made in the application of electrical drives and equipment in the steel mill in the past ten years. At first only small motors and drives were used, these mostly operating at fairly high speeds and self-ventilated. Early generators and motors were of the open frame design and little thought was given to keeping dust and dirt out of the windings, necessitating costly periodic shutdowns to blow out these deposits with compressed air. The constant accumulation of dust, which in the steel mill is mostly composed of particles of iron, steel and carbon, soon forms into a mass, becoming a conductor of electricity, causing short circuits, and often times serious fires. This dust mass also tends to retard radiation causing heating in the windings and consequent loss in efficiency. The same deposit takes place throughout the sub-station on the bus-bars, switches and transformers, becoming a constant menace and requiring frequent cleaning. With recent improvements in large motors, generators and transformers, closing covers with forced circulation and filtered air, has been advocated to protect the machinery, increase its efficiency and reduce the costly shutdowns of past times. Without closing covers and forced circulation it would be impossible to operate the large reversing motors and motors whose speeds are so low as to offer no fan action by the rotor. In all such cases it is necessary to operate a separate fan or blower to force the circulation through this apparatus. Turbo generators and motor generator sets are always of higher speeds, generally sufficient to secure enough fan action by the rotor to be self-ventilating. Here it is possible to supply the necessary air by an independent fan or blower delivering the air to the base of the machine at atmospheric pressure where it is picked up by the fans on the rotor and forced through the windings. In this case, it is always advisable to clean the air supplied. Another application of dissipating the heat from such machines is through the use of a "Closed System," employing a spray type air washer with specially designed eliminator plates; or by inserting in the closed circuit a heat interchanger or surface cooler, using water or other medium as the cooling agent. Either of these systems in a closed circuit necessitates an abundant supply of clean water and expensive pumping equipment requiring considerable power. The entirely "closed" type of recirculating systems, is used principally in connection with turbo generators, and in most recent installations the surface cooler or heat exchanger, has been employed using water as the cooling medium. Some installations have been made in sub-stations containing large reversing motors, MG Sets, and main mill mo-

* Industrial Engineer.

tors, including their various appurtenances, employing recirculation of the air from the sub-station room, passing the same over surface coolers to lower the temperature. In this arrangement the fans and coolers are generally located in the basement in such a manner that the air is delivered to a common basement, or through ducts, leading to the motors and equipment to be cooled, and the air after passing through the motors, etc., returns to the fans, passing over the coolers. However, in this scheme, it is also necessary to add sufficient fresh air, or make-up, to compensate for the loss from the building due to leakage, and to maintain a slight positive pressure on the room. Otherwise, the constant recirculation would have a cumulative effect increasing the relative humidity until the saturation point had been reached, when condensation would take place, and further would tend to create a negative pressure on the room, causing dirt and dust to find its way into the system through infiltration. It is, of course, necessary to clean this air before bringing it into the room. This requires a fan and air filter in addition to the recirculating fans and surface coolers.

Inasmuch as air filtration enters into this scheme, whether the air be recirculated or made up entirely from the outside, it might be interesting to make a rough comparison between the recirculating system and one using air taken from outside the building. Let us take an example of a sub-station containing a large reversing motor, MG set, main mill motors, etc., requiring a total volume of air of 220,000 CFM for a recirculating system. This system will require 170,000 CFM for recirculation and 50,000 CFM for make-up, which will require fans and motors of suitable size to handle the recirculated air, a surface cooler of sufficient size for the total volume together with the necessary pumps and motors for serving the coolers. In addition there will be required an air filter of proper size with fan and motor. The surface cooler will require an average water volume of approximately 650,000 lbs. per hour at 60 Deg. or approximately 1300 GPM which will require a 10" or 12" supply line into the building and return line of the same size. The power required for this system will be approximately 50 Horsepower for the pump and approximately 180 Horsepower for the fans. The air filter would require only one-half Horsepower so this could be neglected.

To handle this same installation with air all taken from outside the building, would require approximately 300,000 CFM based on air at 80 Deg. F., .07322 pounds per cubic foot and 50% relative humidity, and a leaving air temperature from the motors of 120 Deg. F. This system would include air filters to handle the above volume, requiring approximately three horsepower for their operation, together with the necessary fans. The fans would require approximately two hundred horsepower based upon a total pressure of 3" water gage.

The first cost of the system handling all outside air would be about 60% and the installation cost about 75% of the recirculating system. The horsepower required for maximum operation would be about 85% of that required by the recirculating system and would be reduced still further during the winter months when the outside temperature dropped to the average for this season with the latter system. During this period the air supply could be reduced and sufficient recirculation returned to maintain a satisfactory temperature at the filters. The maintenance charges would presumably be about equal as the tubes of the surface coolers would require cleaning, the annual cost of which would be at least equal to the cost of removing the sludge from the filters and keeping the same in operating order. This item could, however, become excessive for the cooler if the water supply were of a dirty nature and contaminated with acids. Even the most favorable water supply will contain a large quantity of solids which precipitate when the velocity or flow is reduced such as must be done in a cooler to secure maximum efficiency, and when contaminated with acids, forms a sticky, or slimy deposit on the tubes, which requires frequent cleaning to maintain a high efficiency of heat transfer.

The life of the apparatus used in either system would be about equal so the depreciation would be the same in either case. Again, this item will depend upon the condition of the water used. The writer believes, however, careful analysis would indicate that the system using all outside air would show the lowest first cost, operating and maintenance cost; and lowest depreciation. Air filters have been developed with very high efficiencies and dependable mechanical design, so that the same high degree of cleanliness can be expected from their use as from the recirculating system, and the problem of suitable constant and adequate water supply can be forgotten.

In many localities recirculating systems are impractical due to an insufficient water supply requiring expensive cooling towers or ponds, or because the water available must be treated before it can be used. In many districts such as Youngstown, Pittsburgh, Wheeling, Johnstown, Bethlehem and practically all inland cities not located on the Great Lakes, the water temperature of the rivers and streams will closely approach atmospheric temperatures, so that the quantity of water required must be greatly increased. This becomes a considerable problem for consideration when aggravated by a continued dry spell such as we have experienced during the past summer; and would undoubtedly result in serious trouble unless some provision were made to supply forced ventilation to machines equipped with water coolers.

The importance of careful investigation of an entirely "closed" system for a turbo generator, will be realized when it is remembered that it requires in the neighborhood of 86,000 gallons per hour or 1140 gallons of water per minute, at 60 degrees Fahrenheit, to supply the surface cooler of a 30,000 KW generator. The motor driving the pump for supplying this water would be practically as large as the motor required to operate the fan for supplying air for such a generator. The spray type cooler, or washer requires considerably less water, but until the manufacturers of these washers can produce equipment that will eliminate free moisture being carried over into the generator, this type will find little favor among experienced Engineers.

Since experience and practice seems to indicate that forced ventilation of electrical equipment is efficient and economical, the problem then resolves itself into the selection of suitable equipment for this

purpose. Considering first the problem of cleaning the air, we must look into the various forms of apparatus available and of proven performance. Many forms of equipment have been designed and offered the public for this purpose including electric precipitation, centrifugal separators, water washers and scrubbers, cloth bag and cloth mat arresters, cloth or felt filters, airmat or sulphite paper filters, unit cell viscous impingement filters and automatic viscous impingement filters. All of these have their proper application for dust removal and separation, but as applied to the cleaning of air for electrical machinery are restricted mostly to the use of water washers, cloth, felt, air-mat, cell or automatic filters. Electric precipitators, centrifugal separators, cloth bag and cloth mat arresters are generally high in first cost and require considerably more power in operation than the other types mentioned. A cloth medium has inherent drawbacks for this service, being extremely sensitive to changes in humidity, affecting the resistance; requiring very low face velocities and considerable exposed surface; and having practically no depth, shows a very rapid increase in resistance requiring elaborate cleaning systems or very frequent blowing out of the medium. Frequently this type of filter is allowed to build up its resistance by infrequent cleaning, to a point as to seriously reduce the air flow, which might result in serious damage to the motor. The airmat or paper type of filter, unlike cloth, is not affected by moderate changes in humidity and has a very low initial resistance; but like the cloth filter shows a rapid increase in resistance under severe service, due to the lack of depth of filter medium. While these filters are generally equipped with rapping devices, yet the maintenance and change of medium when operating under the severe service of the average steel mill, does not recommend its use for this service.

Considerable has been said and written about the use of air washers for this service, but the facts seem to be against this class of cleaning device. The most efficient washers made will not remove a large percentage of the finely divided particles of carbon, soot and solids, such as iron and steel dust particles that so predominate the atmosphere around a steel mill. These are the most harmful particles to the electrical equipment, and if allowed to pass into the system, soon accumulate to a dangerous degree.

The efficiency again depends upon all the spray nozzles operating freely at all times, which requires careful straining of the water. The velocity of the air must not exceed the limits set by the manufacturer or water entrainment will result. Perhaps the most serious drawback to this type of equipment, however, is the fact that there is always present in the atmosphere around the steel mill a large quantity of gases, which, when mixed with the water, form destructive acids which attack the material of the washer, causing it to rust out quickly. This can be overcome, of course, by employing acid-resisting material, but when this is necessary the initial and replacement costs become impractical. The washer must also have frequent attendance to clean out the sludge and mud accumulated in the water tank. Many systems using water washers are being rapidly replaced, as the result of experience, bearing out the above facts.

The continued adoption and use of the viscous coated filter in various forms, seems to indicate that this type of filter remains as the most feasible, economical and reliable means of cleaning air available. While old in principle, it has stood the test of time, and through its wide use, has been constantly improved to meet the ever increasing demands of the industry. Today this filter is manufactured in two distinct forms; the cell or unit filter, which was the original viscous film filter, and which still finds its place in the industry, and the automatic filter, which is the outgrowth of development and improvement, and the answer to the demands of the steel mill for automatic operation, to keep pace with the industry.

The cell type filter will always be found economical and desirable for small units requiring less than 10,000 CFM and for protecting the intakes of air compressors, and blowing engines; and for this purpose should always be used. This is undoubtedly the hardest service under which an air filter must operate, due to the back lash between the intake and discharge impulses. Time has proven that no other type of filter, except possibly the cloth or felt type, which must be renewed so often in this service, can continue to properly function over a period of years under this strain. Automatic filters should not be used for this purpose except on very large installations and only then when proper precaution can be taken to form a considerable air chamber in the line to cushion and absorb the shock.

The automatic filter is the most economical and efficient for systems over 10,000 CFM and if properly installed should give many years of satisfactory service. It should not be forgotten, however, that because the filter is automatic, that it should not receive regular and careful attention to see that the oil level is properly maintained, and that the sludge pan is regularly emptied to prevent the sludge from clogging the filter medium, for after all it must be remembered that the more dirt present in the air and the higher the efficiency of the filter, the more often the sludge pan must be emptied. A large percentage of service calls, due to complaints that the filter was not working properly, have been traced to the negligence on the part of the attendant to properly care for the filter, while reporting to the Operating Department regular inspection of the equipment. However, if a regular and diligent schedule is followed out, there should be no trouble encountered in the use of automatic equipment.

While proper maintenance of any kind of equipment is essential to its success, yet many times the troubles that develop in filter installations are the result of faulty layout, lack of experience in application, or possibly the necessity of cramping the equipment into inadequate space. Filters that have proven successful in many installations have developed trouble in others, due to unfavorable conditions.

In preparing the layout for a filter installation, study should be given to local conditions. The intake should be located above the ground line if possible and in a location that will not throw any excessive or unnecessary load on the filter. The intake should be protected with weather louvres and of a size as nearly equal to the exposed area of the filter as possible, so as not to have an excessive velocity entering the louvres, which might cause free moisture to enter, and greatly increase the dust content of the entering air.

In Northern climates or where the outside temperature is likely to go below forty degrees Fahrenheit, it is always advisable to arrange the filters so that air may be recirculated from the mill in Winter to temper the entering air to a point that will not affect the oil. It is very difficult to obtain an oil with the necessary specifications to hold up in filter service in all seasons and not cause trouble. Very exhaustive laboratory and field tests have been conducted to determine the proper specifications for this oil, and have resulted in securing an oil which will stand up under temperatures ranging from ten below zero up to one hundred and ten degrees Fahrenheit. However, even this oil shows better results when it is permitted to operate between forty and one hundred degrees Fahrenheit, as within this range of temperature, this oil has fairly constant specifications. If the oil is allowed to get too cold, it causes it to thicken and good washing action in the filter cannot be accomplished. On the other hand, if the temperature is permitted to exceed one hundred degrees Fahrenheit, there is danger of evaporation and atomization. It will be readily seen, therefore, that an oil that will perform satisfactorily at high temperatures, will be unsuitable for a very low temperature and vice versa. Many of the troubles reported in air filters of the viscous impingement type have been traced to the attempted use of a cheap grade of oil, which generally has been offered as "just as good," or of "equal specifications" by some ambitious oil salesman, or from a Scotch instinct inherited or attributed to most of us who want to try to keep down operating costs. The attempted use of unsuitable oils always enables the manufacturer to "pass the buck" and blame poor results upon the poor oil, whereas, the wise operator will accept the manufacturer's recommendations and place the responsibility squarely upon his shoulders.

The scheme of recirculation should be carried out so that the returning warm air currents are directed to pass over and thoroughly mix with the cold air so as to eliminate stratification. Sharp bends and cramped airways and ducts should be avoided around the filters, and the air directed as nearly straight at the face of the filter as possible in order that the full area become effective.

The actual volume of air required in any installation will, of course, depend upon several factors, including the actual efficiency or KW loss in the machine, the load, and the efficiency of the air in absorbing the heat given off by the machine. It has been pretty generally accepted, however, that approximately ten to twelve cubic feet of air per minute at eighty degrees Fahrenheit is required for every KW of loss, as against one and one half to two gallons of water per minute at sixty degrees Fahrenheit.

It might be interesting here to show a tabulation of costs covering the application of forced ventilation and filtered air to a large frequency changer in the Youngstown District. The results obtained in this case are very similar to those in many other cases of similar application.

COST OF FORCE-VENTILATION FREQUENCY CHANGER SET—SAVINGS

Investment Data	
4 Multi-Panel Filters	$ 3,260.00
Fan	1,614.00
Fan Motor	507.00
Control equipment	124.00
Switch	35.00
Miscellaneous parts	150.00
Building, structural steel, erection	1,800.00
Total investment	$ 7,490.00
Annual Fixed Charges	
Depreciation (5-yr. life)	$ 1,498.00
Average interest of 6%	269.64
Total fixed charges	$ 1,767.64
Annual Operating Expense	
Fixed charges	$ 1,767.64
Maintenance—	
Motor and fan (estimated)	25.00
Removing sludge—1.6 hr. @ $.65—26 times per year	27.04
Cleaning filters with air—50 hr. @ $.65—once per year	32.50
Adhesive filter fluid—150 gal. @ $1.16	174.00
Power—40 HPx.746/.90x24x180—142,920 KW.-hr. @ $.005	714.60
Total annual operating expense	$ 2,740.78
Savings	
Additional load carried on frequency changer	1,000 KVA
Additional kw.-hr. per year—1,000x.80x24x180 days	3,456,000 kw.-hr.
Savings @ $.003/kw.-hr.	$10,368.00
Less cost of operating fan and filters	2,740.78
Net annual saving	$ 7,627.22
Return on investment ($7,490.00)	101.8%

The selection of the fan to be used in connection with a filter is a very important matter, as many trouble calls have proven the filter to be overloaded as much as fifty per cent, due to the under-estimating of the pressure against which the fan was to work, with a consequent increase in volume handled by the fan. This is the case in practically every instance where a forwardly curved bladed fan has been used, and the resistance was low. In the steel mill a very large percentage of the fans are direct connected to constant speed motors, in which case the fan should be selected at a point of operation where it shows a very steep pressure volume curve, and non-overloading horsepower curve, so that a drop in pressure will not cause the fan to handle an excessive increase in volume with consequent overloading of motor and filter. On the other hand, if the pressure has been under-estimated the fan will not sacrifice an excessive decrease in volume, but will automatically balance up to the actual condition. The unloading type of fan will always permit the use of a smaller motor selected within the maximum horsepower demand of the fan at the speed determined. Of course, where V-Belt drives are used, it is possible to change the

ratio of sheaves to give the necessary speed for the actual condition, but in many cases this is not done and an effort made to operate the filter under overload, which invariably results in a service call. Oftentimes it is desired to operate several fans on a large bank of filters in a common plenum chamber and discharging into a common duct system or basement. In this event, the fans must operate in parallel, and must be of the backward curved blade type in order to secure parallel operation. Where fans are discharging into a common plenum chamber or basement, care should be taken to have the duct connecting the discharge of the fan to the room, expanded sufficiently to drop the speed of the air to about six to eight hundred feet per minute, in order to regain some of the velocity pressure and at the same time slow the air down so it will not pass up the openings nearest the fan. Cases have been observed where this precaution was not taken and it became necessary to construct baffles or shields to direct the air into these openings. The openings in the foundations of machines should be designed so that the air will have an opportunity of entering freely without having to create a high velocity pressure to compensate for this entrance loss, as this loss must be added to the static pressure to form the total pressure the fan must overcome with a consequent increase in power consumption. The openings in the foundations should also be designed so that the entering air is directed as nearly as possible in the direction of rotation of the rotor so as to eliminate swirling and bucking action and insure maximum intimacy of contact in the machine. The velocity of the air entering the closing cover should be very nearly equal to the velocity of the rotor periphery at maximum speed. All new installations should be designed with closing covers and the air directed up under the casing. Where it is desired to equip an old installation with forced circulation of filtered air, the air should, if possible, be brought up under the machine and closing covers should be installed. However, where it is impossible, or the cost would be prohibitive, to come up under the machine, closing covers should by all means be used and designed so that the air will be taken into the cover in tangency with the direction of rotation. Covers can be used on both sides if desired, discharging the air through the frame of the machine, or they may be applied to one end only, forcing the air across the windings. The latter is preferable in the case of a DC motor or generator on account of allowing free access to the brushes. In many cases it is desirable to increase the load on an old type machine due to increasing the speed of the mills, in which case forced ventilation becomes necessary and the question comes up as to whether closing covers are necessary due to the cost of constructing these to fit the machine. However, here it should be remembered that the volume of air required is that necessary to absorb the heat given off by the machine, due to its operating efficiency, and maintain a rise in temperature not to exceed the manufacturer's rating. This is the theoretical volume, or the actual volume if we could expect the air to be so uniformly distributed through the windings as to accomplish 100% circulation. This is impossible even with closing covers, and this theoretical volume becomes only about 60% of that actually required. But without closing covers, this volume must be more than doubled so that it is apparent the smaller volume required by using closing covers will reduce the first cost of the installation of fans and filters, ducts, etc., and will offset the cost of covers, as well as show a continued saving in power for operation.

Duct velocities should be held to a minimum, especially where large volumes of air are being handled. According to tests made to determine the economic velocities for air in ducts, the following data has been recorded:

The area of the main air ducts should be determined by using a velocity in the ducts based on a velocity pressure of 10% of the static pressure. The area of the branch air ducts should be such that the velocity will not be more than 2/3 of that in the main ducts.

The following table shows the relation between velocities and static pressure on the above basis:

Static Pressures	Velocity in Main Air Duct 10% of Static P.
2″	1800
2½″	2000
3″	2200
3½″	2400
4″	2550
4½″	2700
5″	2850
5½″	3000
6″	3100
6½″	3250
7″	3350

The preceding table is based on a weight of air of .07488 lbs. per cubic foot which corresponds to a temperature of 68 degrees F. a barometic pressure of 29.92″ (sea level) and 50% relative humidity. (for higher elevations or temperatures, the above velocities may be increased 1% for each 500 feet increase in elevation, and 1% for each 10 degrees F. increase in temperature).

Any change in the direction of the air flow should be accomplished by means of bends having a radius of throat not less than one-half the diameter of a round duct or one-half the width of a rectangular duct.

With rectangular ducts having a ratio of one side to the other greater than 2/1, lower velocities are recommended; the reduction being 5% for a ratio of sides of 3/1; 10% for ratio sides 4/1; 15% for ratio of sides of 5/1; etc.

Dampers in air ducts should be located at points where the air velocity does not exceed the velocities specified above.

Air ducts should be constructed so as to be smooth and air tight.

Where concrete or masonry ducts are used, the interior surface should be coated with cements, paints, or other materials that will prevent air leakage. If the ducts are of metal construction, particular attention should be given to making the joints air tight.

Where ducts are located underground, sewer drainage should be provided at the lowest point and manholes or doors provided for access to the ducts.

If the fan outlet velocity exceeds the velocity in the main air duct, the connection between the fan discharge and the main air duct should be straight and of such length that the slope of any side rela-

tive to the axis of the duct will not exceed one to eight.

If the discharge connection expands on one side only, the slope relative to the axis of the duct may be one to five.

Changes in sections of the main air duct should be made to conform with the above recommendations.

If the fan outlet velocity is not greater than the velocity in the main duct, the fan may discharge directly into the duct, unless the proportions of the fan outlet and duct are sufficiently different as to require a transformation piece, in which case the above recommendations should apply.

Branch ducts should not be taken from the connection between the fan discharge and the main duct.

Where the direction of air flow in the main duct is constant, branch ducts should be taken off the main duct at an angle of 45 degrees.

Where the air flow in the main duct may be in two directions, the branch ducts should be taken off at right angles to the main duct with a radius of throat not less than one-half the diameter of a round branch duct or one-half the width of a rectangular branch duct.

Only fans with rising pressure characteristics should be used for parallel operation. (A fan is of the rising pressure characteristic type when the pressure curve rises continuously from free delivery to no delivery condition).

If two or more fans discharge into the same duct, the connections from the fan discharges to the duct should be designed so that the frictional loss in each case between the fan discharges and the duct will be equal.

If two or more fans discharge into the same duct with the same and constant direction of air flow, the connections from the fan discharges to the duct should be designed so that the air streams at the point where they merge will be flowing in a parallel direction.

The above data is based upon recommendations of the Stoker Manufacturers' Association and is applicable to air ducts for the service outlined in this paper.

This is accepted as good practice and if followed will invariably show economical results. If steel ducts are used, they should be as tight as possible and all leakage between the fan and filter should be eliminated. If concrete ducts are used, they should be poured with a very rich mixture of cement and faced either with waterproofing cement or bitumastic paint or other plastic material of enduring quality. Tests show that an unlined concrete duct will greatly increase resistance, and will show leakage to the extent of twenty-five to thirty percent of the volume delivered by the fan in one hundred feet of length, with a consequent drop in pressure.

In many large installations the heating of large motor rooms or sub-stations becomes a problem. One of the cheapest and simplest ways to take care of this problem is to allow the fans to recirculate a portion of the air and if the room is fed from a common basement, openings can be placed in the floor against the wall at desired locations and short ducts connected to these, rising about ten feet above the floor with an outlet nozzle. In these ducts can be placed sections of heating coil, such as, Aerofin or Super-fin with a damper for controlling the flow. Oftentimes, however, it will be found that recirculation will hold the room at the proper temperature without adding any heat.

All motor rooms and sub-stations should be vented so that the room can be controlled and a slight pressure maintained on the inside of the building to eliminate any possibility of dirt coming into the building due to infiltration. This can be accomplished either with roof ventilators with dampers or with adjustable louvre dampers.

In many small sub-stations and rooms containing electrical equipment where a large fan and filter would be too costly, it is possible to secure small units complete with fan, filter and louvres all built into a compact unit to fit into a window or other opening in the side of the building. These are ideal for insolated switch houses, automatic sub-stations, telephone exchanges, laboratories, cafeterias, emergency hospitals, and drafting rooms.

Another application for filters in the steel mill that has shown very substantial savings, is in connection with compressed air and gas lines. Considerable moisture and scale form in compressed air lines and is continually working its way into the hammers, drills, etc., causing considerable maintenance and loss of time due to cleaning. This can be eliminated by installing a specially designed filter in the compressed air line feeding these tools. In this application the filter should be used as near the tool as convenient, rather than one large filter located at the compressor, as a great portion of the condensation and scale forms in the branch lines leading to the tools. These filters are also successfully used for filtering gas in mains.

A very interesting application of filters and one of great importance to the steel industry, is in the experimental stage at this time, and shows signs of developing into a reality in the near future; that of cleaning blast furnace gas. This, however, is a tremendous problem and one that will require considerable time to develop satisfactory equipment. In the early stages it appears that air filters can and will be designed to meet this requirement.

It has been the aim of this article, to emphasize in a general way the importance and value of air filtration for conditioning the air about the steel mill, and not to delve into a highly technical treatise of the subject. The information and facts set forth are borne from years of experience gained from the application of fan equipment to steel mill requirements, and from years of extensive study and application of air filters in this and other industries. If any suggestions have been made that may be helpful in working out prospective layouts, or cause more serious thought to be given to air filtration, it shall have accomplished the results which are conducive to maximum co-operation between the Owner, Engineer and Manufacturer.

1930 Developments in Electrical Equipment for Steel Mills

By H. A. WINNE*

While in common with all industry there has been a reduction in steel plant construction during 1930, nevertheless an impressive amount of electrical equipment has been purchased and many interesting developments have taken place. Main roll drive motors, 300 HP and larger, ordered from the General Electric Company during the first 11 months of the year, total 72,650 HP in capacity.

Synchronous Motors

In view of the fact that the first really large synchronous motor in steel mill main roll service, the 9000 HP unit at the Corrigan-McKinney Steel Company's Plant in Cleveland, was purchased so recently as 1925, it is of interest to note that of the total HP given in the preceding paragraph, approximately 32% is in synchronous motors. The synchronous motor has very largely superseded the induction motor for constant speed mill drives, except of course where flywheels are necessary.

Among the more important synchronous motors which have been purchased during the year may be mentioned 2-4500 HP, 156.5 RPM, 6600 volt, 60 cycle units which will drive two rod mills at the Donora, Pa. Plant of the American Steel and Wire Company. This company also purchased one (1) 5000 HP, 360 RPM, 6600 volt synchronous motor to drive a 24" billet mill and one 4000 HP, 360 RPM, 6600 volt, synchronous motor to drive an 18" billet mill at the same plant. This same company put into operation early this year in its Newburgh Works, at Cleveland, a 3000 HP, 100 RPM, 11,000 volt, 3 phase, 60 cycle synchronous motor, driving a 3-high billet mill. This motor is of interest not only because it is one of the very few main roll motors operating at over 6600 volts, but also because it is started from rest by connecting directly to the 11000 volt circuit.

The Weirton Steel Company has purchased for its Clarksburg, W. Va. Plant, two synchronous motors, one 2000 HP, 300 RPM, and one 1000 HP, 360 RPM, which will drive hot tin mills. This is believed to be the first installation of synchronous motors on mills of this character, previous practice having been to use induction motors with flywheels. Synchronous motors were chosen because of the necessity of maintaining a good power factor in order to earn a low rate on the purchased power, and also because of the gain in efficiency. Not only is the synchronous motor itself more efficient than the corresponding induction motor, but the friction and windage losses of the usual flywheel and the power losses in the secondary resistor or liquid slip regulator are eliminated. It is expected that the power per ton of tin plate rolled will be at least 5% to 10% less than if an induction motor flywheel drive had been used. Of course as there are no flywheels on the drive, the motors must carry the maximum peak loads of the mill, and therefore, the continuous capacities of the motors were made about 25% greater than they would have been had induction motors been used. Even so, the first cost of the installation will be lower than that of the conventional induction motor drive. The synchronous motors will develop 250% of normal torque with normal field excitation, and in case the load exceeds this value, a relay will automatically strengthen the field enough to permit the motor to develop 300% of normal torque without pulling out of step.

Wherever the power system will withstand the shock, it is desirable to start synchronous motors at full line voltage, as this requires the least amount of switching and control equipment. Next in simplicity is the reactor method of starting at reduced voltage. Several installations have been made, in which instead of having the starting reactor in the line between the power system and the motor, it is placed in the neutral connection of the motor, which of course must be Y connected. With the reactor placed at the neutral, a comparatively inexpensive oil circuit breaker of low short-time current capacity may be used for short circuiting the reactor, as this breaker will always be protected against heavy short-circuit currents by the reactance of the motor winding itself.

Another method of simplifying the control equipment where several synchronous motors are located in a common motor room, is to use a single starting reactor connected between the main bus and a starting bus. The various motors are then started by connecting them first to the starting bus and then to the main bus. This system works perfectly satisfactorily, even though the motors may be of widely varying capacity. This is true because all main roll drive synchronous motors are, or should be, designed to withstand starting at full voltage and the only reason for starting at reduced voltage is to limit the peak load on the power system. It is obvious that if the starting reactor is so designed as to limit the load on the system to a reasonable value when starting the largest motor in the motor room, the load on the system when starting the smaller motors will be still lower, altho these motors will get a higher percentage starting current in proportion to their normal current than will the large ones. This reactor starting bus system is in use in several mill installations.

Reversing Mill Drive

An 8000 HP, 40/100 RPM reversing motor is now being built to drive a 44" blooming mill at the Gary Works of the Illinois Steel Company. This motor will be capable of developing a maximum torque of 2,900,000 lbs. at 1 ft. radius. The mechanical parts of this motor, including the armature spider, will be of fabricated steel construction throughout. Several reversing motors of General Electric manufacture with fabricated and electrically welded armature

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spiders have been in service for some time, demonstrating beyond possibility of doubt the reliability of this type of construction. Power for the 8000 HP motor will be supplied by a 375 RPM motor generator set, consisting of 2-3500 KW, generators, 1-6000 HP, 6600 volt, 25 cycle induction motor and 1-200,000 HP-second flywheel.

DC Main Drives

The Illinois Steel Company is installing at its South Chicago Works a 10" alloy bar mill, driven by 9-DC motors totaling 7,627 HP. Some of these motors have a speed range of approximately 5:1, which is obtained partly by motor field adjustments and partly by armature voltage control through the use of auxiliary bucking generators, one for each of the two motors which have this large speed range. The use of these bucking generators permits operating the three main 1750 KW, 600 volt generators in parallel at constant bus voltage. The motors will be equipped throughout with speed regulators of the vibrating type, designed to hold the speed regulation within very close limits.

The 23" continuous hot strip mill of the Great Lakes Steel Corporation was put into operation in 1930. This mill has ten stands, each driven by an individual direct current motor. The drive for this mill has one very interesting feature. When rolling from slabs of such lengths that the piece will reach from stand #4 to stand #5, the section of bus to which the first four motors and 1-5000 KW generator set are connected, is segregated from the bus to which the remainder of the motors and the other motor generators are connected. This is necessary because the minimum speeds of the first four motors when operating at normal rated voltage are such that the metal would be delivered from stand #4 at a very much higher speed than it enters stand #5. Consequently, when the piece is continuous between stand 4 and 5, the speeds of the first four stands must be lowered by reducing the voltage of the generators on the section of bus to which the first four motors are connected.

However, in order to reduce the total time required for a slab to go through the mill when rolling on a schedule of this nature, the first four motors operate at full voltage whenever there is no steel in the space between stands 4 and 5. That is, a slab enters stand #1 at a comparatively high rate of speed and passes on through stands 2, 3 and 4. When the front end of the piece gets a little distance out of stand 4, it strikes a limit switch which causes the voltage and speed of the first four motors to be reduced to a point such that the delivery speed of stand 4 corresponds to the entrance speed of stand 5. Then, when the tail end of the strip leaves stand 4 and passes beyond the limit switch, the voltage and speed of the first four motors is automatically brought back to the normal value. This arrangement permits of a considerable saving in time in the rolling of long slabs without necessitating a long spacing between stands 4 and 5. A similar arrangement was incorporated in the control of the first two motors on the 60" wide strip mill in the Wheeling Steel Corporation's Steubenville, Ohio, Plant.

During the past year there has been considerable activity in connection with cold strip mills, and Steckel mills. The Steckel mill is a type of cold rolling mill in which the metal is drawn back and forth through the main rolls by motor driven reels, one located at each side of the main roll. The rolls themselves are not driven. On the majority of the mills so far installed a single motor is used, this being connected alternately to the two reels through clutches. However, the Weirton Steel Company is now putting into operation a mill of this type in which each reel is driven by an individual 500 HP, direct current motor. As it is necessary to maintain a certain amount of tension in the strip between the mill and the trailing reel, the motor on the trailing re-reel acts as a generator in order to maintain this tension and an automatic regulator provides for maintaining the tension at any desired value. In passing from the reel to the mill, the strip rides over a floating roller which, through a system of levers and pivots, is connected to the contact arm of a regulator and to a scale beam having a sliding weight. The contacts of the regulator act across the motor field, while the sliding weight on the scale beam permits of readily adjusting the tension at which the regulator will operate.

Switchgear

The so-called metal clad type of oil circuit breaker is now coming into wide use in steel mill service. This type of breaker is ideally suited to steel mill duty. It is a very safe breaker as all live parts are completely enclosed, and the breakers cannot be removed from its operating position unless it is first opened. All buses and insulators are enclosed and protected from dirt and dust. A breaker can be very readily removed for inspection and a spare substituted in place of it. In this respect it is superior to the truck type of construction, for steel mill service, because of the fact that the circuits are usually of varying capacity, requiring current transformers of different size for the different breakers. With the truck type of construction these current transformers are usually mounted in the trucks, so that the various trucks cannot be used interchangeably on circuits of different capacity. With the metal clad construction the current transformers are mounted in the bus structure and the removable and interchangeable unit comprises simply the breaker itself, so that so long as all breakers purchased are of the same capacity, they may be used interchangeably.

Motor Room Ventilation

Considerable study has been given to the question of motor room ventilation, and two more installations are being made in which the motor room and basement will constitute a completely closed air system. Air will be forced through the motors into the motor room, thence into the motor generator sets and from them into the basement where it will be drawn through water cooled air coolers and again circulated. A separate filter and fan will be provided to supply the necessary small amount of make-up air to the system, and the pressure in all parts of the system will at all times be maintained slightly above the outside atmosphere so that there should be no ingress of dirt to the motor room. Furthermore, the temperature of the motor room will be much below that which is obtainable with other systems. This method of ventilation will be used in

the Illinois Steel Company's 10″ alloy mill at South Chicago and in their 44″ blooming mill at Gary.

Auxiliaries

The majority of the motor-driven heavy shears, such as bloom and slab shears, which are now in operation, are driven through clutches by induction motors equipped with flywheels. The mechanical clutches are a source of more or less trouble, and to eliminate these and also the losses in the continuously running motor and flywheel, several shears have recently been installed with direct current motor drives arranged to start and stop for each cut.

Two of these are in the new plant of the Great Lakes Steel Corporation near Detroit. The larger of the two is an 800 ton slab shear, designed to cut a slab 8″ thick x 25″ wide. This shear is driven by two MD-420-200 h.p. compound wound, forced ventilated, 230 volt motors. The control is arranged so that when it is desired to make a cut the operator simply throws a master switch. The driving motors immediately start and accelerate at a very high rate to a speed considerably above their normal rating. Then while the cut is actually being made, the motors are automatically slowed down so as to take advantage of the inertia of the moving parts to help make the cut, and thereby reduce the electrical load on the motors. As soon as the cut is actually completed, the motors again speed up, making the return stroke at high speed. The shear is decelerated by dynamically braking the motors, and finally stopped with the blades in the open position by a solenoid brake. From actual test, it has been found possible to operate the equipment at the rate of 14 cuts per minute.

Another mid-western steel plant has recently placed in operation eight shears, cutting cold stock up to a maximum of ¼″ thick x 42″ wide. Each shear is driven by an MDS-416-100 h.p.-230 volt compound wound motor. The control on each shear is arranged so that the motor starts and stops for every cut, the operator simply throwing a master switch to initiate a cycle. Some idea of the high rate of acceleration and deceleration may be obtained from the fact that the shear makes a complete cycle in less than one second, and during this time the motor starts from rest, attains a speed of over 450 r.p.m., cuts the plate, and stops.

What is believed to be the first application of synchronous motors to flying shear drive is in connection with the 20″ hot strip mill in the Great Lakes Steel Corporation's plant. The shear is of the Mesta rotary flying type, and, to insure that the metal shall be cut into equal lengths, it is necessary that the speed of shear be synchronized with the delivery speed of the metal from the mill. As the metal may be delivered from any one of the last three stands, it must be possible to synchronize the shear with either of these stands. To accomplish this, on the drive for each of these three stands an a-c. generator is provided, and the shear is driven by a synchronous motor, the power for which may be obtained from any one of the three a-c. generators.

In order to provide means for adjusting the length of metal cut, a Waterbury hydraulic adjustable speed gear is interposed between the synchronous motor and the shear itself. By means of this gear, the ratio of the speed of the shear itself to that of the shear-driving motor may be adjusted at will, but once adjusted, remains set and therefore, synchronized with the delivery speed of the metal itself. In actual practice, it has been found that the length of the pieces of strip can be maintained constant with a variation of less than ⅛″.

In the modern continuous wide strip mills "loopers" are placed between the finishing stands to throw loops in the metal and prevent any tendency to buckle. These "loopers" are usually small diameter rollers mounted on lever arms in such a way that they may be raised up against the underside of the moving strip. It has in the past been customary to operate these looping devices by either hydraulic power or compressed air. In two recent strip mill installations, that of the Wheeling Steel Corporation at Steubenville and the Great Lakes Steel 20″ strip mill, these loopers are actuated by direct current motors of the MD-400 type acting as torque motors.

As the finishing stands of these mills are driven by individual, direct current motors, it is possible to control the looping motors by relays which are responsive to the loads on the main driving motor. For example, consider the looper between stands 8 and 9. In the armature circuit of each of the main driving motors is connected a load relay so adjusted that it will not operate on the motor load due to the friction of the empty stand, but it will pick up whenever the motor is loaded due to steel in the mill. When the strip enters stand #8, the load relay on motor #8 picks up, but this has no effect on the looper between stands #8 and #9. As the strip passes along and enters stand #9, the resultant load on motor #9 will cause this load relay to pick up. The closing of this relay, so long as the relay on stand #8 remains closed, will actuate the control to apply power to the torque motor on the looper between stands #8 and #9, causing the looper roller to lift up against the underside of the strip and raise the strip until it is taut between the two stands. The looper roller is held up against the strip with a pressure dependent upon the torque value for which the looper motor is adjusted. As soon as the tail end of the strip leaves stand #8, the load relay on motor #8 will drop and this action will cause the control equipment to momentarily reverse the power on the looper motor, causing the looper roller to quickly return to its lower position and remain there until strip again reaches from stand #8 to stand #9.

As standard 230-volt MD-400 motors are used for the looper drives, it is evident that the voltage across the armatures must be limited to a low value to prevent excessive current and torque. To avoid the large power loss which would result if the armature were placed in series with a resistor, across the 250 volt mill circuit, a small motor generator set generating direct current power at about 30 volts is used to supply the armatures of the looper motors. Then no series resistance is necessary. The motors are shunt wound with their fields excited from the 250 volt circuit and their torque may be adjusted within limits by adjusting the shunt field.

Shunt wound MD-400 motors designed for adjustable speed operation are now being used in large numbers for various mill auxiliary drives where speed adjustment is necessary such as on run-out tables, reelers and coilers, levelers, conveyors and edging rolls. These adjustable speed MD motors, which

are available with speed ranges by shunt field control up to 2.5:1, or even 3:1, are filling a long felt want for an adjustable speed auxiliary motor of the same rugged construction and reliability as the standard series and compound wound MD motors. These motors are built in the A. I. & S. E. E. standard frames, and in many cases the armatures are identical with those of the standard series and compound wound mill motors, thus reducing the number of spare parts which must be carried in stock.

During 1930, the General Electric Company placed on the market a new line of direct current solenoid brakes, for mill and crane duty. These brakes are of the band type. The construction is extremely simple and necessary adjustments can be made very quickly. Rolled steel wheels are used.

Vacuum Tubes

While at first thought, it may appear that a steel mill is no place for so fragile a device as a vacuum tube, still we must not forget that for some years, these tubes have been found to be reliable and rugged enough for automatic train control service. Now they are beginning to find their way into the mills.

For example, photo-electric tubes are now in successful use on a pipe facing machine in a large tube mill. Each facing machine has two movable cutting heads. When a length of pipe is clamped in position in the machine, these two heads must advance to within ¼" of the end of the pipe and stop there. The heads are motor driven. Obviously, any type of mechanically operated limit switch mounted on the head and actuated by conatct with the end of the pipe was out of the question, as the switch would be in the way of the cutting tool after the head was brought to a stop. Consequently, photo-electric tubes were used, a tube and a light source being mounted on each cutting head in such a way that as the head approaches the pipe, the end of the pipe intercepts the beam of light between the source and the photo-electric tube. Shutting off the light de-energizes the tube, which in turn causes the control equipment to stop the travel motor, when the head is ¼" from the pipe.

It seems probable that the photo-electric tubes will prove very useful as limit switches and in other ways. They are also used to turn lights on and off, depending on the amount of daylight available.

The thyratron is another type of vacuum tube which has been found useful. This is a rectifying tube, the DC output voltage of which can be controlled by adjusting the potential on its grids. The thyratron is in use on wire drawing machines to control the tension in the wire between the die and the motor driven reel. The wire passes over a system of pulleys, so arranged that any tendency of the reel to increase or decrease the tension in the wire will raise or lower a pulley which is mechanically connected to the movable core of a small reactance coil. The reactance coil is connected in the grid circuit of the thyratron. Any movement of the core of the reactor changes the reactance in the grid circuit and consequently, varies the phase angle of the potential on the grid, thus changing the DC output voltage of the tube. The DC output of the tube is used to supply power to the armature of the reel motor, whose shunt field is separately excited, and therefore any change in this voltage causes a corresponding change in the motor speed. The connections are so arranged that if the reel tends to increase the tension in the wire and thereby causes the reactor core to lift, the motor automatically slows down, and vice versa. Thus the system is at all times maintained in a balanced condition with the proper tension on the wire. The tension may be adjusted by changing the weight on the core of the reactor or by adjusting a spring which helps to support this core.

Electric Furnaces

The Bethlehem Steel Company in its Bethlehem, Pa. Plant is now operating a large electric furnace installation for heat treating alloy and high carbon steel. Two of these furnaces are of the pit type, each capable of taking a charge of 50 tons of steel in the form of bar stock 25 ft. long. The inside dimensions of each furnace are 27 ft. long x 8'6" wide x 6'6" high. The heating elements are of the ribbon resistor type with a connected load of 1100 KW at 220 volts, 3 phase, on each furnace, divided into 6-control sections, 3-along the top and 3-along the bottom.

The material to be heat treated is loaded into U-shaped racks or cradles made from castings of heat resisting alloy. Each furnace holds two of these cradles. Special lifting beams are provided so that a crane may lift the cradles and set them evenly down in the furnace.

Each furnace has a removable cover extending the full length, which is handled by a special crane which travels over the two furnaces. As a means of accelerating the cooling portion of the cycle, pipes of heat resisting alloy extend across the underside of the cover and are connected to a duct system. A blower is arranged to blow air through the pipes, thus extracting heat from the furnace chamber without admitting air to the chamber itself. This arrangement gives comparatively rapid cooling without excessive oxidation of the charge.

The installation also comprises a double chamber car bottom type of furnace. Each chamber is 5 ft. wide and capable of handling bar stock up to 25 ft. long. Cradles and lifting beams are used to handle the stock in much the same way as for the pit furnaces. The ribbon resistor heating units in each chamber have a connected load of 700 KW.

The remaining unit of this large electric furnace installation is a roller hearth type of furnace used for normalizing or quenching bar stock 25 ft. in length. This furnace has a capacity of 6000 lbs. of steel heated per hour to 1650 deg. F. The total connected load of the ribbon resistor heating units is 975 KW.

The roller hearth furnace together with its pre-heating and quenching equipment is entirely automatic in operation. From the time a charge of bars is placed on the charging table, until they are delivered on the drainage rack over the quenching tank, the operation is completely automatically controlled. When a charge is removed from the furnace, the charge which is already in the pre-heating chamber automatically advances into the main furnace chamber, and the charge which is lying on the charging table is automatically pushed into the pre-heating chamber as soon as the preceding charge has entire-

ly moved out of it. The charge which is in the main furnace chamber is held there for a predetermined definite length of time and is then automatically delivered onto the quenching racks which are suspended from the quenching crane. The crane then immerses the charge in the quenching tank jogging it up and down for a pre-determined length of time, and then delivers it on the drainage rack.

The length of time for each portion of the cycle is readily adjustable as is, of course, also the temperature of the furnace. The control equipment is fully interlocked so that all operations must take place in the proper sequence. This installation may truly be said to be the last word in this type of equipment.

These furnaces have been in operation for a few months and very satisfactory results are being obtained.

A Review of Combustion Engineering

Fuel represents an approximate average of 15 to 30% of the total cost of the manufacture of steel, depending on the diversity of manufacture, and the proportion of finished or semi-finished products. In addition to this direct charge is the consideration of the effect of heating operations on mill production and practice, and on the quality of the product. These indirect items may easily amount to as much as, or even more than, the direct fuel charge. Viewed from this angle, it is apparent that the field of combustion work in the steel plant is a wide one, and worthy of the utmost attention. With the ever-increasing interest in costs resulting from the prevalent keen competition, it is not strange that managements should take active interest in the matter.

The result of this interest has been a great development in the field of combustion engineering. As is usual in the case of any rapid development, the very speed tends to keep the matter in a state of flux, and prevents the "freezing" so necessary to obtain solidarity of form, or organization. Combustion engineering is therefore a highly elastic term. A brief survey of the various plants brings forth an array of ideas greatly at variance as to organization and duties of combustion departments. While the character of these departments must necessarily be influenced by the character and organization of their respective plants, there is certainly not apparent between combustion departments the similarity existing between other comparable departments. Numbers of employees vary almost beyond comparison. Duties may include checking and compilation of data, surveys, design, or operation, either singly or in any combination. While these differences are of no serious consequence, some degree of uniformity would no doubt be beneficial, and there is here a field of inquiry which should prove both interesting and helpful. With this diversity present in the work covered, a review of the developments in combustion engineering must cover a wide range of subjects.

In the field of steam generation, the process of centralization of production continues. New boiler installations have attained sizes undreamed of a few years previous. The economy effected by this trend needs no comment here. Technical literature is flooded by proof, if indeed we do not have an example in our own back-yard. In these modern plants, firing equipment is chosen specifically for the fuel to be burned. While the problem of using a fuel in equipment more or less unsuitable may be interesting, the practice is not economical. We therefore find chain grate stokers where coke braize is to be burned, well-designed burners for gaseous fuels—in short, equipment fundamentally suited to the purpose. To take care of fluctuations in the supply of the various fuels, increasing use is made of combination furnaces, designed to be fired with various fuels, either singly or in combination. In surveying existing installations, almost any combination can be found, but the use of pulverized coal seems to be gaining favor. Its economy as a primary fuel and its flexibility as a supplementary fuel present advantages easily apparent.

Furnace design, in general, has improved, tending to follow more rational lines of heat generation and application. Furnaces of any size are no longer designed by "rule of thumb", but are based on the principles of heating practice and heat flow, insofar as they are known. Dissemination of the known data on these subjects has resulted in greater interest in further research, and the increased knowledge is reflected in modern furnace design. In some cases, radical changes were called for, and no small amount of prejudice had to be overcome before developments could proceed.

Increased use is made of radiant heat transmission, while, in some cases, greater effort is made to preheat the stock, thus reducing the heat content of the gases leaving the furnace. Furnace atmosphere and temperature distribution have received greater attention. Improvement in this direction has come largely through study of the movement of gases in the furnace, resulting in a decentralization of heat generation in the furnace. Supported arches and walls and plastic refractories have made possible the execution of designs heretofore impossible. Monolithic furnace hearths have been particularly successful.

The use of preheated air is growing, as a result of the desire to capture every possible B.T.U., as well as of the improved transmission qualities of the flame thus obtained. Recuperators and preheaters of various designs are on the market, and can be obtained to fit existing installations. Where such changes have been made, increased production has been obtained, usually accompanied by a lower fuel rate, and operators are very enthusiastic over the results. There is one instance of a recuperator applied to a regenerative type pit furnace fired with blast furnace gas, in which the air is given a temperature of about 1000° F., before entering the regenerator.

Recuperators or air preheaters are used with one-way soaking pits, of which there are several designs.

These one-way pits are generally accepted as superior to the old reversing regenerative type. Excellent heating is obtained with good fuel economy, and operators are very much in favor of their application. Preheated air supplied to these pits usually falls between 900 and 1500° F.

In the effort to conserve every possible B.T.U., increased use is made of heat insulation. Furnaces now use insulation of thicknesses previously unheard of, though this is governed by the type of fuel used. Even in comparatively low temperature installations we find as much as 9" of insulation. In the open hearth, insulation of checker chambers, bulkheads, etc., is finding favor, preventing air infiltration as well as reducing radiation. Where heavy insulation is applied, several different types are usually used, each type having successively lower heat conductivity, with a correspondingly low ability to stand up under temperature.

In the past two years, sheet and pair furnaces have probably passed through more radical changes than any other type. Brought to this country by the Welshmen years ago, sheet mill practice was handed down almost intact. True, minor improvements were made in furnace design, but heating methods remained basically identical. The development today is in two directions. The continuous wide strip mill, served by one or more large continuous furnaces, has been gradually developed until it assured of a permanent place in the making of this type of product. However, for full finish sheets, as demanded by metal furniture, automobiles, etc., the trend is toward the double-mill system of rolling, with continuous sheet and pair furnaces, usually one to each mill. Some of these furnaces utilize chain conveyors, but the walking-beam hearth furnaces seem to receive greater favor. These furnaces are usually well insulated, equipped with automatic control, and operate with excellent economy. Furnace atmospheres are maintained but slightly reducing, a condition under which the production of full finish sheets was formerly held impossible.

Sheet normalizing furnaces are comparative newcomers to our mills, introduced to meet the demand of the trade for normalized sheets. These furnaces are of the continuous type, from 60 to 175 feet long, and employ either a roller hearth or a walking-beam hearth. The latter is the newer development, and is proving very satisfactory.

With the ever-widening demands to be met in the production and processing of steel, we find special purpose furnaces designed to perform some specific operation. While such furnaces should be, insofar as possible, basically sound in design from a combustion and heat application standpoint, there is imposed on the designer a matter of greater import —that of meeting the peculiar conditions demanded by the special process—, and if necessary, combustion principles must be sacrificed. Some of these furnaces then seem to break almost every rule of furnace design, and the casual observer is prone to criticize on these grounds. It should be realized, however, that such cases present many difficulties, demanding considerable research and development, and it is creditable to combustion engineers and to furnace manufacturers that the difficulties have been met, on the whole, in satisfactory ways.

No resumé of furnace design is complete without a consideration of the materials entering into furnace construction. These materials fall into two main classes, refractories and metals, and the progress made in both fields is comforting to furnace designers.

The quality of refractories in general has been improved through a better understanding of the conditions to be met and a more careful supervision of manufacture. Special refractories have been developed to meet extreme conditions of service, and special shapes can be obtained to meet special conditions of construction. Carborundum refractories enjoy greater use, and provide great advantages as to heat resistance and transmission. There has also been developed a special refractory of light weight, with a lower specific heat than firebrick. This means that less heat is stored in the furnace walls, and consequently, quicker temperature changes can be obtained. This is of particular interest in the low temperature heat treating furnaces.

The development of heat-resisting alloys has made furnace designs practical which were previously impossible. Most of our continuous furnaces are more or less dependent on heat-resisting metals, and with their constant improvement, increasing use is being made of them. In England, a new product has been announced which claims to have the strength at 2000° F., now possessed by our present alloys at 1600° F. Research is constantly going on, and there is even the possibility that alloys of the future may be of an entirely different character than those in use at present.

A promising application of heat-resisting alloys has been made in sheet annealing boxes. Formerly of cast steel, all previous developments have consisted of slight changes in design so as to obtain maximum rigidity with minimum weight. Boxes are now available of chrome-nickel steel, stamped and welded to shape. These boxes weigh approximately only 15% as much as the old cast boxes, which means less heat stored in the box. The lower rate of heat transmission of the alloy is more than balanced by the thin construction. Many operators using them report very favorably.

Some form of control is usually applied to modern furnaces of any consequence. These controls are in a variety of types, and so great has been their progress that a control can be found to fill almost any demand. Temperature control of heating and treating furnaces is quite common. The application of complete combustion control, including temperature, damper and fuel-air ratio control, is increasing in large heating furnaces, and great interest has been aroused in open hearth control. In this last field exists no well established practice. Various installations have been made, with no two alike. In some cases, automatic furnace reversal has been used. Others use fuel-air ratio and damper control. From this experimentation good results have been obtained in fuel economy, production and furnace life, and we may safely expect some gradual development toward a general unified practice.

Advances have been made in the utilization of fuel. The tendency to apply all gaseous fuels to metallurgical heating is growing. Various applications have been witnessed and discussed by the Association, with generally favorable comment. A new development which is being tried out in several

instances is that of atomization of liquid fuel by means of high pressure gas. Gas, compressed to 100-125 pounds pressure, as the sole atomizing agent, is supplied to burners similar to any high pressure atomization burner. The amount of gas required depends on the kind of gas used, a lighter gas requiring greater volume for atomization. Excellent flame characteristics are obtained, and reports indicate that time of heats is materially reduced, while furnace life is lengthened.

Gas producer practice has, in general, improved. Greater application of instruments and controls, and the intelligent use of data obtained from them have produced greater economy and higher rates of production in the gas-making process. A recent development in producer design makes use of water-cooled walls in the combustion zone. Heat thus lost in the cooling water is more than balanced by the improved condition of the fuel bed.

It will be noted that the entire discussion has, in its final essence, centered around economy. Every development has tended to eliminate waste or increase production, and, under the stress of present day competition, this trend will no doubt be furthered. Certain developments which would save fuel cannot, in many cases, be justified from a financial standpoint, due to the low price of fuel. This regrettable condition can be altered either by increased fuel prices, or reduced prices on fuel-saving equipment. Relative to the first factor, government regulation of fuel prices has already been suggested. The latter factor presents a problem to equipment manufacturers and to combustion engineers in general.

Many other problems confront the combustion engineer. There are many processes and practices about which too little is known. New data on such matters is gradually brought forth, but there is need for more universal effort in furthering the information. Existing data should be brought together and correlated. There should be a constant, free exchange of ideas. Every man in the field should participate in this work. They who contribute nothing obtain small returns, and their slight progress is made at the expense of others. Our Association, through its transactions and publications, presents every opportunity for this phase of the work. With whole-hearted co-operation we will go forward, and can face to the front, confident that developments of the past will be overshadowed by progress in the future.

1930 Electrical Developments

By A. F. KENYON*

During the year 1930, there has been a general recession from the unusually high operating rates of the preceding year, and an accompanying reduction in expenditures for improvements and new plant facilities. The present low rate of plant operations affords opportunity to carefully analyze the existing equipment and to develop plans for projects to be undertaken later when economic conditions are more favorable.

The following tabulation indicates the types of main roll drives which have been sold during 1930 by the Westinghouse Electric and Manufacturing Company.

Type of Drive	No. of Units	Total HP.
D.C. Reversing	6	21750
D.C. Continuously Running	23	14600
25 Cycle Induction	4	4140
60 Cycle Induction	8	6050
60 Cycle Synchronous	4	3000
TOTAL	45	49540

The 10,000 HP. Twin-Motor equipment, developed last year for the drive of a 54" reversing blooming mill, was placed in operation in 1930, and represents the maximum power yet installed for the drive of a single mill stand. However, there is now under construction a 44" universal slabbing mill drive having a continuous capacity of 12,500 HP. and a maximum emergency capacity of 35,000 HP. The upper and lower horizontal rolls are to be individually driven by two 5000 HP. 40/80 RPM. reversing motors, constituting a Twin-Motor drive of 10,000 HP. 4,000,000 pound-feet maximum torque capacity, duplicate of the 54" blooming mill drive now in operation. The vertical edging rolls are to be driven by a third reversing motor, rated 2500 HP. 79/225 RPM. 500,000 pound-feet maximum torque capacity. 700 volt direct current power for the three reversing motors will be furnished by a 10,500 KW. flywheel motor generator set consisting of a 180,000 pound flywheel, a 6500 HP. 25 cycle, 6600 volt, 370 RPM. induction motor, and three 3500 Kw. 700 volt generators connected in parallel. This installation will be of unusual interest to steel mill engineers because of the large size of the mill and the electrical equipment, and also because of the method of drive utilizing three reversing motors with control to provide adjustment of relative speeds thus permitting variations in drafting and the use of horizontal rolls of unequal diameters.

To secure the necessary refinement for the accurate automatic control of the screwdown mechanisms on a 32" three-high universal plate mill and roughing and intermediate 52" universal structural mills, seven variable voltage screwdown equipments have been installed. The variable voltage control permits much more accurate settings than can be obtained with rheostatic control, either with auto-

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matic or manual operation, and thus speeds up the operation of the entire mill. A further advantage is the elimination of the large capacity reversing and accelerating contactors and starting resistor, with accompanying lowered maintenance. Thus far variable voltage control has been applied only to screwdowns and for the purpose of securing greater refinement and accuracy necessary for automatic limit switch control, but on future large mills it is probable that variable voltage operation will be extended to other of the heavy active mill auxiliaries, such as main tables, sideguards, and manipulators.

In 1925 there was developed and installed a system of control by which the soaking pit covers in a large structural mill could be opened or closed from the cab of the soaking pit crane, as well as from the usual floor master switches. This system has proven entirely successful but necessitates sectionalized control rails along the crane runway to make connections with the crane cab master switches. During the past year, an installation has been made in which light sensitive vacuum tubes are mounted along the runway opposite each soaking pit. On the crane cab is a spot light-directed on the light relays and by turning this spot light on or off the crane operator may open or close the soaking pit covers. The newer scheme performs identically as the earlier development but does not require the system of control rails and collectors.

In modern high speed continuous bar and merchant mills it is desirable to provide one or more vertical roll stands to permit working the steel on all sides without twisting the bar between stands. Several such vertical stands with bevel gear drive and horizontal motors are in operation. A 10" bar mill now under construction will have the two vertical stands driven by 800 HP. 195/495 RPM. and 800 HP. 285/705 RPM. vertical direct current motors, mounted on a structural steel frame above the vertical rolls and pinions. This is believed to be the first application of vertical main roll drive motors to eliminate the bevel gearing required with horizontal motor drive, and represents a distinct improvement over previous methods of drive.

In conventional switchboard practice, separate metering and control panels are provided for the control and indication of oil circuit breaker equipment. In a large wrought iron plant recently completed, considerable floor space was saved and the time and cost of installation reduced by providing a 30" high superstructure and meter and control panels above the 6600 volt truck type oil circuit breaker structure, thus eliminating the separate meter and control panels. The complete structure was entirely erected and wired at the manufacturer's plant, thus assuring a finished factory assembled product and saving the usual conduit and wiring. With the necessity for conserving floor space this type of equipment should find large use.

Improvements are being made in air conditioning and ventilating equipments for large mill drives. Efficient high speed propeller type fans, already successfully applied in marine boiler room draft service, have been installed for the ventilation of the motors and motor generator sets and motor rooms of a new structural mill. Seven fans of a total capacity of 410,000 cubic feet of air per minute are used, and the higher efficiency of the propeller type fans as compared to the usual centrifugal fans permitted a reduction of about 150 HP. in the ratings of the driving motors.

The electrical losses in large mill drives require very large volumes of ventilating air, and the maintenance of the air washers or filters is a considerable item when all outside air is used. Also, on warm summer days it is often difficult to maintain comfortable temperatures for the station attendants and the electrical machines. These defects in existing ventilating systems have resulted in several installations of closed recirculating and cooling systems in which the motor rooms are closed tightly and the ventilating air cooled in surface air coolers and recirculated through the machines and motor room. A small volume of filtered makeup air is continuously added to compensate for air leaks from the recirculation system and to maintain the system under pressure to prevent the infiltration of dirt.

The laying of long pipe lines for the transportation of oil and gas has created a demand for large tonnages of steel pipe ranging from 8" up to 30" in diameter. Such sizes, with relatively thin walls, can usually best be produced by forming and welding flat plate or strip material. The several pipe manufacturers have conducted extensive experiments and developed various methods of electric welding. By one of the more successful methods in commercial operation, the edges of the plate are welded by current developed by using the plate as a transformer secondary.

Rolling mill bearings must operate at high unit pressures, and the selection of suitable bearings is one of the important phases of mill design and construction. Considerable experimental work has been done toward the improvement of the design of the conventional types of babbitt and bronze lined bearings, and a new type of bearing has been introduced by the successful operation of several sets of duck bakelite Micarta bearings on rod mills. Bearings of this material require only water for lubrication, they can be made in any required size, the quality is uniformly high, and experience indicates a life of several times that obtained with bronze or lignum vitae.

Open Hearth Combustion Control

By MARTIN J. CONWAY†

EDITOR'S NOTE:—A previous article entitled "Combustion Control of Open Hearths," by Mr. Conway appeared in the Proceedings of the Association of Iron and Steel Electrical Engineers for 1925. Since that time there has been great activity in the development of automatic furnace control. The author has done much research work in the field of automatic control and his knowledge of this subject has been attained through years of practical experience.

Just before the advent of the basic open hearth process a little over half a century ago, A. L. Holley, the most noted American metallurgist and steel works engineer of his day, wrote in one of his reports in summing up his conclusions about the open hearth process as follows:

"While the Bessemer process has reached a high degree of perfection, so high, indeed, that the directions of great improvement are not obvious, the open hearth is availing itself of new accessories in every direction. The Bessemer looks back to a splendid development. The open hearth looks forward to a splendid development."

The late S. T. Wellman once recalled a prophecy by Holley that the open hearth process would some day go to the funeral of the Bessemer, but the time has not yet arrived to make even tentative arrangements for its obsequies.

In fact, it looks as if both processes will work together for an indefinite period, as there is room for both so long as the cost of producing basic Bessemer Steel is less than that of basic open hearth, and there may be some purposes for which Bessemer Steel is preferred. Holley's prophesy regarding the development of the open hearth process has been borne out in fact. The world output of open hearth steel in the year of Holley's prediction was 350,000 tons as against nearly 100,000,000 tons in 1929, and, during this time probably the greatest single improvement in practice was S. T. Wellman's invention, the charging machine.

Perhaps the most notable improvement since Wellman's invention is the widespread development of automatic combustion, temperature and draft control which has taken place during the past few years. The advantages of automatic control cannot be fully obtained unless and until the management, combustion, and operating departments are sympathetically sold to its use, and, of the many substantial investments that have been made during the past ten years to improve "cost above net metal" performance in open hearth practice, none have given the quick return, that has in general been the case where control has been installed.

Combustion control for open hearth furnaces is by no means a new art, but great care must be exercised in the selection of proper equipment to suit specific conditions, and usually the best method is to introduce the control by steps, not only on the first furnace equipped, but on each furnace as equipped. The most important step in open hearth furnace control is automatic stack draft control, and contrary to supposition while producing the greatest benefit, is the most difficult to obtain.

The importance of waste gas control was pointed out by the writer six years* ago, but while efforts have been made to accomplish this in the interim it is only during the past two years that these efforts have met with a measure of success.

On looking back, and tracing the sequence of the various operations which have led up to this interesting development, one is struck by the fact that the whole process is reasonably simple. The mistakes which are obvious today, but which were unknown previously, appear almost absurd in their simplicity. Fuel economy is not the only benefit which has accrued.

The approximation to perfect combustion, and waste gas control that is now being obtained has meant that, while the fuel cost has been considerably reduced, the tons per furnace hour and heats per furnace campaign have been considerably increased, so that the final end has been achieved, by the combined process of increased output together with reduced fuel consumption.

A further remarkable result, has been the marked increase in the life of the furnace, the net result being a very decided reduction in the cost of ingot production.

The use of control apparatus has brought out the necessity of employee training and individual tuition is the order of the day. The intelligent furnace man requires to be told the reason why: it is not sufficient to tell him to do this, that, or the other. His individualism requires that he should be made part of the project which it may be necessary to carry out, and, in so far as the carrying out of an instruction he may receive, may differ from what he has absorbed while graduating to his present position, and needs to be combined with something he cannot apply himself, requires the careful consideration on the part of any man, who would be a successful department head. We come, therefore, to the point that, given suitable conditions the best results to be obtained from these conditions must be covered by the extent to which the man in control is able to carry out his ideas through the medium of his workmen.

There is no royal road to learning, and it is impossible to lay down, hard, and fast rules as to how such results can be achieved in every open hearth plant. That is a matter which must be settled between the individual management and workmen at any one plant, and constitutes a really vital test as to managerial efficiency.

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* Proceedings Iron and Steel Electrical Engineers for 1925, Page 379.

J. A. Clauss, Chief Engineer of the Great Lakes Steel Corporation, subsidiary of National Steel Corporation. Mr. Clauss' initiative and experience as an operating as well as a designing engineer are evidenced at every point in the new $25,000,000 plant which has just been put in operation at Ecorse, Michigan. He is an active member of the Association of Iron and Steel Electrical Engineers and is serving on important National Committees of the Association.

Steel in Detroit

By J. A. CLAUSS*

With the completion and the putting into operation of the first unit of the Great Lakes Steel Corporation at Ecorse, a suburb of Detroit, Michigan, the year 1930 will be noted for the beginning or rather the return of the steel industry to this area.

Many of our members may be unaware of the fact that in the neighboring City of Wyandotte, almost within the shadow of the site of this newest giant of the steel industry, in the early eighteen fifties, there was the nucleus of a flourishing steel industry and that in 1864 the first Bessemer converter in America was erected and the first steel rails made. Here in the City of Wyandotte are many of the descendants of those early pioneers, and there are still living here many men well past middle life who spent their early boyhood working in these mills. These men have vivid recollections of this early steel plant, and one is impressed with the comparative youth of the steel industry and the wonderful progress that has been made in the art of steel-making when one considers that, within the span of a man's life, we have seen the steel mill develop from a few tons' production a day to the thousands of tons' production of our modern plants.

Few people coming to Detroit realize that this area was chosen for this early effort in steel-making because of its nearness to a supply of ore and limestone and an abundance of timber for charcoal. While the timber has mostly disappeared, the raw materials required for the steel industry are still easily obtainable, and the fuel question has been settled by the use of fuel oil and a generous use of electrical appliances.

We are wont to marvel at the daring courage and shrewdness of the early pioneers in the steel industry, and we frequently hear reference to the romantic careers of the early steel masters. There is still romance in the steel industry and it still requires courage of a high order to project in a new and untrod field, on a site which presented natural difficulties, a modern steel plant.

Future historians of the steel industry will record the courage and shrewdness of the founders of this newest member of the steel industry.

In the short space of less than eighteen months there has been erected and put into operation, on what was once a waste marsh, a gigantic steel plant complete in every detail and with the last word in modern equipment. Electricity has here been used to its fullest extent in conjunction with the latest mechanical equipment.

The best engineering thought available has been put into this modern giant, and it is to the everlasting credit of the many engineers engaged in the development and installation of steel mill equipment that, as a result of their combined efforts, there has been produced the most modern steel plant in the world in one of the largest steel-consuming centers of the world.

More and more the engineer is coming into his own in the steel industry. The day of brute strength and sledge hammer adjustment has passed. Modern inventions have made mill adjustment available by the simple act of pushing a button.

A few men, almost unseen, unless one is familiar with the modern mill layout, control the entire operation.

The developments and improvements during the past five years in the steel industry have been rapid and startling in their effect on old established practice.

Less than five years ago we saw the advent of four-high mills, and there were many skeptics as to the usefulness of this type of mill. Today no one would think of building a wide strip mill without going to some form of backed-up working roll.

The development of anti-friction or roller bearings in rolling mills is taken as an accepted fact. Five years ago they were almost unheard of in steel mill equipment. We are now progressing to the point where anti-friction bearings are being specified not only for the mills, but for the pinions, drives, roller tables, and miscellaneous equipment.

Each improvement brings along with it other problems. In the old days we slapped on grease right and left without rhyme or reason so long as there was plenty of it; however, today with the advent of modern roller-bearing machinery, lubrication becomes a problem of the first order and we introduce the Lubricating engineer alongside of the Mechanical, Electrical, and Combustion engineers.

It is evident from the mass of printed matter passing over the desk of the steel mill engineer that many are working on this problem. As we gather data, compare notes, and discuss this problem, we will change our preconceived notions and successfully solve this problem. In the field of combustion we daily hear of wonderful fuel records in the production of steel and reheating. So all down the line the steel mill engineer is meeting the issue and leaving behind him a wonderful story of development as he reaches for the next problem.

To the members of our Association, the achievements of the past must be the spur that guides them on to still greater achievement.

* Chief Engineer, Great Lakes Steel Corporation, Ecorse, Mich.

Some Notes on Underground Cables

By E. S. SIMKINS, Cleveland, Ohio

The last few years have witnessed an enormous growth in underground distribution of electric power in industrial plants, especially in steel mills. It has reached the point in many plants where the distribution system is comparable in size and investment to that in many moderate sized cities. As a natural outgrowth of this, the matter of careful engineering of such cable plants is assuming major proportions and warrants careful study on the part of engineers in order that the investment in cable may be efficiently utilized.

Engineers have three principal kinds of insulating materials from which to make their selection in choosing the type of cable best adapted to their problem. The three insulating materials are rubber, varnished cambric, and paper. The differing characteristics of these materials govern the selection of the proper size of conductor to transmit a given load under specified conditions.

When calculating the size of cable for a particular installation the engineer has two major factors to consider—line loss and the temperature limitations of the insulating material. Usually, however, it will be found that when the temperature limitations are fulfilled the line loss will be well within the desired figures unless the length of the line is very long or there are unusual circumstances surrounding the installation. It would be well, then, to consider for a moment what these temperature limitations are, how they are applied to current carrying calculations and, briefly, the merits of each kind of insulating material.

There are several formulas in use today for calculating the current carrying capacity of cables but they are all based on one fundamental—the temperature rise of the copper conductor to the maximum allowable. This maximum allowable operating temperature has been standardized by the A. I. E. E. and is expressed for the three classes of insulation as follows:

Rubber	60 Deg. Cent. minus E/4
Varnished Cambric	75 Deg. Cent. minus E
Paper	90 Deg. Cent. minus E

Where E equals the kilovolts of the line.

The ambient temperature depends entirely on local conditions but for ordinary calculations, under average soil conditions, is generally considered as 20 Deg. Cent. But considering 20 Deg. Cent, as the base temperature, and other things being equal, it is obvious that rubber has the lowest current carrying capacity, varnished cambric next, and paper the highest. While there are other factors entering into the final result they are not sufficiently large to change the general relationship.

As just stated, rubber insulation is the least efficient from a current carrying standpoint. It is likewise the most expensive in first cost under normal market conditions, except for small conductors at low voltage. On the other hand, rubber is non-hydroscopic and should the lead sheath be damaged from any cause the cable will continue to operate for a considerable time before failure occurs. For long vertical runs rubber insulation is often preferred because it contains no liquid compounds to drain to the bottom.

Varnished cambric insulation stands about midway between rubber and paper in allowable operating temperature. It has approximately 15 degrees higher allowable temperature rise which, when translated into current carrying capacity, means, at low voltage, about 11 percent increased allowable current over rubber, other things being equal. This advantage increases to about 15 percent at 5,000 volts. Conversely it means that a smaller conductor may be used for the same load and at times this is a governing factor especially when duct space is limited.

Aside from the consideration of current carrying capacity, varnished cambric insulation stands up well under high voltage rises due to switching, etc., which makes it especially desirable in industrial work. It can be bent on a compartively short radius, requires only moderate skill in jointing and is partially non-hydroscopic—hence it is not likely to fail immediately should the lead sheath be damaged. On the other hand, it is not especially well adapted to high voltage work as its dielectric loss is high and ionization of voids is a dangerous possibility. The generally accepted voltage limit for varnished cambric today is 17,000 volts but other insulating materials should be carefully analyzed when voltages higher than 7,500 are being considered.

Paper insulated cable is obviously the most efficient of all cables when considered strictly on the basis of current carrying capacity. It has, however, three inherent disadvantages from the mill man's standpoint. It requires greater skill in handling and jointing, potheads can never be omitted, and, should the lead sheath be damaged from any cause, its hydroscopic nature will quickly result in failure. However, where large blocks of power must be transmitted for comparatively long distances at higher voltages, the inherent advantages of paper cable cannot be rejected because of the few disadvantages. Higher allowable copper temperatures permitting greater current density in the conductor, when combined with low dielectric loss, frequently result in the use of fewer cables to transmit the load. At voltages above 10,000 volts the shielded type of cable tends to increase these advantages rapidly, to the end that smaller duct structures can be built with the resultant lower investment and better operating conditions.

While it is compartively simple to calculate the amount of cable required to transmit a given load under assumed conditions it is not so easy to be assured that the assumed conditions obtain throughout the entire length of the duct runs. Soil and other conditions vary from foot to foot of the length of the subway to the extent that the assumed ambient temperature does not prevail uniformly through the entire distance. This may be especially true if the duct line crosses or parallels a steam line for a short distance. Hot spots such as these are therefore the limiting condition in the run and unless avoided or circumvented in some way, they be-

come the determining factor in the rating of the cable.

Knowledge of conditions is the key to the successful operation of cables. Therefore, the engineer cannot go too far in his investigation of the temperatures in the duct runs. Temperature surveys are highly desirable as a means of determining whether or not any extraordinary conditions exist. Such surveys are tedious and somewhat expensive to make but the result in the prevention of costly cable failures due to overheating and overloading, more than repays for any expenditure of time or money.

Maximum reading thermometers, recording thermometers, single and multiple-couple thermo-couples are used to make temperature surveys, the selection depending on the time and the completeness of the survey to be made. Of these the multiple-couple thermocouple is to be preferred because the temperature of a number of points may be read at the same time while with a single thermocouple or other single reading instrument must be drawn through the duct and allowed to remain at each reading point until a constant reading can be obtained.

Calculations of current carrying capacity of cables bring out clearly that as the number of cables in a duct bank is increased the capacity of each cable decreases. The decrease is in the order of from seven to ten percent per cable as additional ones are added. It is clear, then, that a point is soon reached where additional cables in a bank do not permit carrying more load. This point was not generally recognized a few years ago and it was common practice to build large duct banks. From fifty to eighty ducts were not uncommon and their builders pointed to them with pride. However, it is now recognized that the soil surrounding the duct structure will absorb just a certain amount of heat and when more heat is generated by multiplying the number of cables, a point is soon reached where the soil is incapable of carrying it away. This has the effect of holding the heat in the duct structure to a point where the cables are dangerously overheated and failures occur.

Recognition of the thermal characteristics of the duct structure and the surrounding soil has completely changed the design of duct structures. Now as few ducts as possible are built into one run even if it is necessary to duplicate the run at some little distance. Ten ducts or at the most twelve are considered the maximum for an ideal structure and these are being built so that all ducts will be outside. In other words, they are being built two ducts wide and five or six high. Any other arrangement leaves one or more tiers of inside ducts which are less efficient than outside ones. Special and complicated calculations are necessary to determine the proper load on the cables in the inside tiers when the outside ones are fully loaded. These calculations will show very much lower current density than if the ducts were in a better radiating position. It is generally more economical to build two smaller lines of ducts than one large line if more energy must be transmitted than can be safely carried in a few cables in one duct structure.

So far only the subjects of insulation characteristics and duct structures have been discussed and these only in so far as they effect the problem of the current transmitting properties of cables. This does not mean, however, that the details of construction and installation can be neglected if the future safety of the system is to be an objective.

Regardless of the type of insulation selected it is essential that the cable be handled in installation with due regard to its mechanical and electrical properties. As a chain is only as strong as its weakest link so a cable is only as strong as its weakest point. This leads to a consideration of methods of installation.

Duct structures should be built in as nearly a straight line as possible and where abrupt changes in direction are essential, a manhole should be built at the intersection to facilitate making the turn when cable is pulled. Sometimes with a light cable a length can be pulled around this hole without cutting but where the cable is heavy a cut should be made and afterward spliced. Pulling strains on the cable should be watched carefully. If there is any doubt about the safety of drawing a cable into a given duct, information should be obtained from the cable manufacturer as to the maximum allowable pulling strain. Dynamometers should be used to be sure that the maximum pulling strain is not exceeded.

At one time, anyone who could wipe a joint was considered a cablesplicer. That time has passed and now cablesplicing is a recognized trade and one entirely apart from that of the wiring electrician. Only skilled men should be employed for cable splicing and such men furnished with the best of materials with which to work. Many argue that they do not have enough work about their plants to justify employing a cable splicer full time. Where this condition exists it is wise to employ outside help temporarily. This is usually expensive in unit cost as the worker's travelling and living expenses must be included, but is justified by better workmanship and greater safety against future cable failures.

The protection of cables afer installation is essential to their life. Fire-proofing in manholes and on exposed station ends is fully warranted by the protection given against the results of possible failure of one cable being transmitted to all of the neighboring cables. There are two methods of fire-proofing in common use—asbestos wrapping and cement over a rope wrapping. One is apparently as efficient as the other and the choice depends largely on the initial cost of the materials. Frequent bonding of cables is essential if electrolysis is suspected.

Pothead protection on the ends of cables is always essential. Some engineers argue that the expense is not warranted on low voltage cables especially with rubber or varnished cambric insulation. However, the consensus of opinion is that potheads should be used on all cable ends. Their use affords complete protection from the elements and from the deleterious influences of air, dirt, and moisture. They also provide efficient separation and insulation of the conductors from each other and from the grounded lead sheath. When selected for the purpose they can be used to separate the cable from other apparatus.

These and other considerations of underground cable development are all important to the successful operation of any system. No attempt has been

made here to go into any details concerning methods of calculating cable ratings or into the details of duct line building and cable installation. The purpose has been to bring out a few of the things worthy of mature consideration and to suggest the careful study of the many excellent articles on the subject which have been published in technical journals in recent years.

MAIN ROLL DRIVE STATISTICS—1930

MAIN DRIVE MOTORS SOLD 1930

ALL MOTORS 300 H.P. OR OVER

Companies	Total H.P. Purchased 1930
American Rolling Mill Company	1400
Aluminum Company	5400
American Steel & Wire Company	19600
American Tube & Stamping Company	2000
Algoma Steel Corporation	5000
Babcock & Wilcox Company	1200
Buffalo Steel Company	500
Canton Tin Plate Company	1200
Canadian Steel & Tube, Ltd.	2000
Calumet Steel Company	2000
Chase Brass & Copper Company	300
Crucible Steel Company	800
Carnegie Steel Company	11090
Dallas Brass & Copper Company	1000
Gulf States Steel Company	1500
Great Lakes Steel Company	6900
Illinois Steel Company	53100
Inland Steel Company	3750
Jones & Laughlin Steel Corporation	7350
Michigan Steel Tube Company	300
Michigan Steel Company	3000
National Tube Company	14350
J. A. Roebling Sons	450
Safety Cable Company	1000
Tennessee Coal, Iron & R. R. Company	2300
Timken Roller Bearing Company	1200
Weirton Steel Company	8250
Wheeling Steel Corporation	500
Worth Steel Company	1000
Total	158440

Total Motors Purchased In Iron & Steel Industry	H.P. Per Motor
4	300
3	350
11	400
1	450
4	500
13	600
2	700
11	750
5	800
7	900
4	1000
1	1140
2	1200
2	1250
5	900/1400
1	1500
1	900/1500
1	1600
2	1500/1800
8	2000
1	2250
2	2500
3	3000
6	3500
2	4000
2	4500
4	5000
1	8000
109	

VOLTAGES USED ON MAIN ROLL DRIVE MOTORS

No. Motors Purchased	Voltage
1	220 A.C.
4	230 D.C.
14	250 D.C.
4	440 A.C.
47	600 D.C.
1	650 D.C.
1	680 D.C.
2	700 D.C.
1	800 D.C.
7	2200 A.C.
1	2300 A. C.
1	4000 A.C.
1	4400 A.C.
2	4600 A.C.
22	6600 A.C.
109	

COMPILATION

109 Main Drive Motors over 300 H.P. purchased in 1930
70 Main Drive Motors over 300 H.P. used D.C.
39 Main Drive Motors over 300 H.P. used A.C.
Speeds—64 Motors D.C. adjustable speed
2 Motors A.C. adjustable speed sets
43 Motors constant speed

Of the 39 A.C. Motors, 15 were 25 cycle and 24 were 60 cycle

Method of Drive

77 Main Roll Drive Motors over 300 H.P. were geared
29 Main Roll Drive Motors over 300 H.P. were direct
1 Main Roll Drive Motor over 300 H.P. was belted

Motors and Types of Drives Purchased in 1930

No.	Type
16	Synchronous Motors
5	Blooming Mill Drives
3	Rail and Structural Mill Drives
9	Plate Mill Drives
10	Sheet and Tin Plate Drives
3	Rod Mill Drives
1	Piercing Mill Drive
13	Tube Rolling Mill Drives
6	Strip and Hoop Mill Drives
35	Merchant Mill Drives
1	Wire Mill Drive
3	Non-Ferrous Mill Drives
14	Bar and Billet Mill Drives
1	Cold Roll Mill Drive
7	Reversing Mill Drives

Electricity's Contribution To The Iron & Steel Industry

Main Roll Drives Installed in 1930 in the United States and Canada

With this issue of the Iron and Steel Engineer we are publishing a tabulated list of main roll drives installed in the Iron and Steel Industry during year 1930.

In the past this information has been published in cataloged forms by the different manufacturing companies, each catalog including only those installations involving their own equipment. It has always been difficult for the electrical engineer in the steel industry to properly analyze the information included in these various publications because of the wide differences in the method of tabulation used by the various manufacturers.

In this tabulation the Iron and Steel Engineer is presenting the information in a uniform manner showing the Horse Power, R.P.M., Voltage, Cycles, Type and Size of mill, Method of drive, date of purchase, name of plant and location. Also a classified list which gives the types of installations in Blooming Mills, Plate Mills, Rail and Structural Mills, Bar and Billet Mills, Sheet Bar and Skelp Mills, Sheet and Tin Plate Plants, Rod Mills, Piercing Mills, Tube Mills, Strip and Hoop Mills, Merchant Mills, Wire Mills, Aluminum, Brass, Copper and Non-Ferrous Mills; also the Multi-Speed Drives, A.C. Speed sets, Direct Current Adjustable Speed Drives and Reversing Blooming Mill Drives are tabulated.

This data has been prepared with the view of providing the Executives, and Engineers in the Iron and Steel Industry an authority, and a reference manual for their guidance in future installations and extensions.

A complete list of all main roll drives, over 300 H.P. installed in the Iron and Steel Industry up to the year 1930 will be found in the 1929-1930 Proceedings of the Association of Iron and Steel Electrical Engineers.

H.P.	R.P.M.	Volts	Cycle	Type of Mill	Drive	Date	Customer	Location	Mfgd. By
300	150-300	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
300	400-800	230	DC	Tube Push Bench	Geared	1930	Chase Brass & Copper Co.	Cleveland, Ohio	GE
300	600	6600	60	Cold Mill	Geared	1930	Tenn. Coal, Iron & R. R. Co.	Fairfield, Ala.	GE
300	600	220	60	16" Slug Rolling	Geared	1930	Michigan Seamless Tube Co.	So. Lyon, Mich.	EM
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
*400	106	2200	60	12" Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
*400	112	2200	60	10" Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
400	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	200-600	600	DC	Cold Strip Mill	Geared	1930	United States Aluminum Co.	Alcoa, Tenn.	W
*400	300	400	60	Copper and Brass	Geared	1930	Dallas Brass & Copper Co.	Chicago, Illinois	EM
400	370	440	25	44" Blooming Mill Edger	Geared	1930	Illinois Steel Co.	Gary, Ind.	W
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
450	154	2200	60	Wire Drawing Mill	Direct	1930	John A. Roebling Sons	Trenton, N. J.	EM
500	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	225-450	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	270-750	250	DC	Cold Strip Mill	Geared	1930	Wheeling Steel Corp.	Steubenville, Ohio	GE
500	750	4400	25	Rail Rerolling Mill	Geared	1930	Buffalo Steel Co.	Tonawanda, N. Y.	GE
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	228-800	250	DC	10" Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
600	228-800	250	DC	10" Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
*600	300	440	60	Reversing Copper	Geared	1930	Dallas Brass & Copper Co.	Chicago, Ill.	EM
600	300-600	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	96" Plate Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	AC
600	300-600	600	DC	96" Plate Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	AC
600	365	6600	25	Reeler Machine	Geared	1930	National Tube Co.	McKeesport, Pa.	AC
600	365	6600	25	Reeler Machine	Geared	1930	National Tube Co.	McKeesport, Pa.	AC
600	490	6600	25	96" Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
600	585	2200	60	Bar Mill	Geared	1930	American Rolling Mills Co.	Ashland, Ky.	W
700	300-750	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
700	300-750	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
750	120-360	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	South Chicago, Ill.	GE
750	180-450	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	South Chicago, Ill.	GE
750	300-700	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	South Chicago, Ill.	GE
750	300-700	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	South Chicago, Ill.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	450-900	600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	GE
750	450-900	600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	GE
800	195-495	250	DC	10" Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10" Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10" Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	270-670	250	DC	10" Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	795	2300	60	Sheet Mill	Geared	1930	American Rolling Mills Co.	Ashland, Ky.	W
900	100-300	600	DC	14" Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE

H.P.	R.P.M.	Volts	Cycle	Type of Mill	Drive	Date	Customer	Location	Mfgd. By
900	100-300	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14″ Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	255-610	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	310-765	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	380-765	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
1000	200-600	600	DC	14″ Merchant Mill	Direct	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
1000	360	6600	60	4-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
1000	600	6600	60	Sheet Mill	Geared	1930	Worth Steel Co.	Claymont, Del.	GE
1000	715	440	25	Copper Mill	Geared	1930	Safety Cable Co.	Baltimore, Md.	W
1140	480-493-570	6600	25	Merchant Mill	Belted	1930	Carnegie Steel Co.	Youngstown, Ohio	W
1200	150-300	230	DC	Tube Mill	Geared	1930	Timken Roller Bearing Co.	Canton, Ohio	GE
1200	585	2200	60	Tin Plate Mill	Geared	1930	Canton Tinplate Co.	Canton, Ohio	W
1250	60-120	600	DC	22″ Bar Mill	Direct	1930	Carnegie Steel Co.	Duquesne, Pa.	W
1250	100-200	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900-1400	40-63-190	380-600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	GE
1500	83 1-3	6600	25	Piercing Mill	Direct	1930	National Tube Co.	Gary, Ind.	AC
950-1500	128-202-580	380-600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	GE
1500	250-625	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
1500	300	4600	60	Sheet Mill	Geared	1930	Michigan Steel Co.	Detroit, Mich.	GE
1500	300	4600	60	Sheet Mill	Geared	1930	Michigan Steel Co.	Detroit, Mich.	GE
1500	600	6600	60	Sheet Mill	Geared	1930	Gulf States Steel Co.	Birmingham, Ala.	GE
1600	490	6600	25	Roughing Mill	Geared	1930	Carnegie Steel Co.	Duquesne, Pa.	W
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
2000	165-330	600	DC	84″ Aluminum Mill	Direct	1930	Aluminum Co. of America	Alcoa, Tenn.	GE
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC
2000	300	6600	60	8-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
2000	450	2200	60	18-10″ Rod Mill	Geared	1930	Canadian Tube & Steel Prod., Ltd.	Montreal, Canada	GE
2000	514	2200	60	Sheet Mill	Geared	1930	American Tube & Stamping Co.	Bridgeport, Conn.	GE
2000	590-450	4000	60	Rail Rerolling	Geared	1930	Calumet Steel Co.	Chicago, Ill.	W
2000	600	6600	60	Hot Sheet Mill	Geared	1930	Tenn. Coal, Iron R. R. Co.	Fairfield, Ala	GE
2250	65-90	600	DC	28″ Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE
2500	79-225	700	DC	44″ Slabbing Mill, Vertical Edger	Geared	1930	Illinois Steel Co.	South Chicago, Ill.	W
2500	100-200	600	DC	14″ Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
3000	65-130	680	DC	32″ Billet Mill	Direct	1930	National Tube Co.	McKeesport, Pa.	W
3000	70-140	650	DC	24″ Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE
3000	90-180	600	DC	144″ Aluminum Mill	Direct	1930	Aluminum Co. of America	Alcoa, Tenn.	GE
3500	165-330	660	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
4000	360	6600	60	18″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
4000	370	6600	25	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill	W
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	W
5000	50-120	700	DC	28″ Rail Mill	Direct	1930	Algoma Steel Corp.	Sault Ste. Marie, Ont.	W
5000	360	6600	60	24″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
8000	40-100	800	DC	44″ Blooming Mill	Direct	1930	Illinois Steel Co.	Gary, Ind.	GE

SYNCHRONOUS MOTORS

300	600	220	60	16″Slug Rolling	Geared	1930	Michigan Seamless Tube Co.	So. Lyon, Mich.	EM
400	106	2200	60	12″ Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
400	112	2200	60	10″ Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
400	300	440	60	Copper and Brass Mill	Geared	1930	Dallas Brass & Copper Co.	Chicago, Ill.	EM
450	154	2200	60	Wire Drawing Mill	Direct	1930	John A. Roebling Sons	Trenton, N. J.	EM
600	300	440	60	Reversing Copper	Geared	1930	Dallas Brass & Copper Co.	Chicago, Ill.	EM
1000	360	6600	60	4-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
1500	83 1-3	6600	25	Piercing Mill	Direct	1930	National Tube Co.	Gary, Ind.	AC
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC
2000	300	6600	60	8-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
2000	450	2200	60	18-10″ Rod Mill	Geared	1930	Canadian Tube & Steel Prod., Ltd.	Montreal, Can.	GE
4000	360	6600	60	18″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
5000	360	6600	60	24″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE

BLOOMING MILL DRIVES

400	370	400	25	44″ Blooming Mill, Edger	Geared	1930	Illinois Steel Co.	Gary, Ind.	W
2500	79-225	700	DC	44″ Slabbing Mill, Vertical Edger	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	W
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	W
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	W
8000	40-100	800	DC	44″ Blooming Mill	Direct	1930	Illinois Steel Co.	Gary, Ind.	GE

RAIL AND STRUCTURAL MILL DRIVES

500	750	4400	25	Rail Rerolling Mill	Geared	1930	Buffalo Steel Co.	Tonawanda, N. Y.	W
2000	590-450	4000	60	Rail Rerolling Mill	Geared	1930	Calumet Steel Co.	Chicago, Ill.	W
5000	50-120	700	DC	28″ Rail Mill	Direct	1930	Algoma Steel Corp.	Sault Ste. Marie, Ont.	W

PLATE MILL DRIVES

600	300-600	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
600	300-600	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
600	490	6600	25	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC

SHEET AND TINPLATE DRIVES

H.P.	R.P.M.	Volts	Cycle	Type of Mill	Drive	Date	Customer	Location	Mfgd. By
800	795	2300	60	Sheet Mill	Geared	1930	American Rolling Mills Co.	Ashland, Ky.	W
1000	360	6600	60	4-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
1000	600	6600	60	Sheet Mill	Geared	1930	Worth Steel Co.	Claymont, Del.	GE
1200	585	2200	60	Tinplate Mill	Geared	1930	Canton Tinplate Co.	Canton, Ohio	W
1500	300	4600	60	Sheet Mill	Geared	1930	Michigan Steel Co.	Detroit, Mich.	GE
1500	300	4600	60	Sheet Mill	Geared	1930	Michigan Steel Co.	Detroit, Mich.	GE
1500	600	6600	60	Sheet Mill	Geared	1930	Gulf States Steel Co.	Birmingham, Ala.	GE
2000	300	6600	60	8-Stand Tin Mill	Geared	1930	Weirton Steel Co.	Clarksburg, W. Va.	GE
2000	514	2200	60	Sheet Mill	Geared	1930	American Tube & Stamping Co.	Bridgeport, Conn.	GE
2000	600	6600	60	Hot Sheet Mill	Geared	1930	Tenn. Coal, Iron & R. R. Co.	Fairfield, Ala.	GE

ROD MILL DRIVES

2000	450	2200	60	18-10" Rod Mill	Geared	1930	Canadian Tube & Steel Prod., Ltd.	Montreal, Can.	GE
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
4500	156.5	6600	60	Rod Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE

PIERCING MILL DRIVES

1500	83 1-3	6600	25	Piercing Mill	Direct	1930	National Tube Co.	Gary, Ind.	AC

TUBE ROLLING MILL DRIVES

300	400-800	230	DC	Tube Push Bench	Geared	1930	Chase Brass & Copper Co.	Cleveland, Ohio	GE
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
350	480	6600	25	Reeler Mill	Geared	1930	National Tube Co.	Gary, Ind.	AC
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	365	6600	25	Reeler Machine	Geared	1930	National Tube Co.	McKeesport, Pa.	AC
600	365	6600	25	Reeler Machine	Geared	1930	National Tube Co.	McKeesport, Pa.	AC
1200	150-300	230	DC	Tube Mill	Geared	1930	Timken Roller Bearing Co.	Canton, Ohio	GE
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC
2000	250	6600	25	Tube Rolling	Geared	1930	National Tube Co.	Gary, Ind.	AC

STRIP AND HOOP MILL DRIVES

400	200-600	600	DC	Cold Strip Mill	Geared	1930	United States Aluminum Co.	Alcoa, Tenn.	W
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26" Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
500	270-750	250	DC	Cold Strip Mill	Geared	1930	Wheeling Steel Corp.	Steubenville, Ohio	GE

MERCHANT MILL DRIVES

300	150-300	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	106	2200	60	12" Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
400	112	2200	60	10" Merchant Mill	Direct	1930	Crucible Steel Co.	Syracuse, N. Y.	W
400	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	200-400	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	225-450	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
700	300-750	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
700	300-750	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
750	120-360	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	180-450	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	300-700	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	300-700	600	DC	10" Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10" Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	450-900	600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	450-900	600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
900	100-300	600	DC	14" Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14" Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14" Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14" Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
1000	200-600	600	DC	14" Merchant Mill	Direct	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
1140	480-493-570	6600	25	Merchant Mill	Belted	1930	Carnegie Steel Co.	Youngstown, Ohio	W
1250	100-200	600	DC	14" Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900-1400	40-63-190	380-600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
950-1500	128-202-580	380-600	DC	10" Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
1500	250-625	600	DC	14" Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
2250	65-90	600	DC	28" Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE
2500	100-200	600	DC	14" Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
3000	70-120	650	DC	24" Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE

WIRE MILL DRIVES

450	154	2200	60	Wire Drawing Mill	Direct	1930	John A. Roebling Sons	Trenton, N. J.	EM

ALUMINUM, BRASS, COPPER AND NON-FERROUS MILL DRIVES

400	300	440	60	Copper and Brass	Geared	1930	Dallas Brass & Copper Co.	Chicago, Ill.	EM
600	300	440	60	Reversing Copper	Geared	1930	Dallas Brass & Copper Co.	Chicago, Ill.	EM
2000	165-330	600	DC	84" Aluminum Mill	Direct	1930	Aluminum Co. of America	Alcoa, Tenn.	GE

BAR AND BILLET MILLS

H.P.	R.P.M.	Volts	Cycle	Type of Mill	Drive	Date	Customer	Location	Mfgd. By
600	228-800	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
600	228-800	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, O.	W
600	585	2200	60	Bar Mill	Geared	1930	American Rolling Mills Co.	Ashland, Ky.	W
800	195-495	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	270-670	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	255-610	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	310-765	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	380-765	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
1250	60-120	600	DC	22″ Bar Mill	Direct	1930	Carnegie Steel Co.	Duquesne, Pa.	W
3000	65-130	680	DC	32″ Billet Mill	Direct	1930	National Tube Co.	McKeesport, Pa.	W
4000	360	6600	60	18″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE
5000	360	6600	60	24″ Billet Mill	Geared	1930	American Steel & Wire Co.	Donora, Pa.	GE

COLD ROLL MILL DRIVES

300	600	6600	60	Cold Mill	Geared	1930	Tenn. Coal, Iron & R. R. Co.	Fairfield, Ala.	GE

DIRECT CURRENT ADJUSTABLE SPEED DRIVES

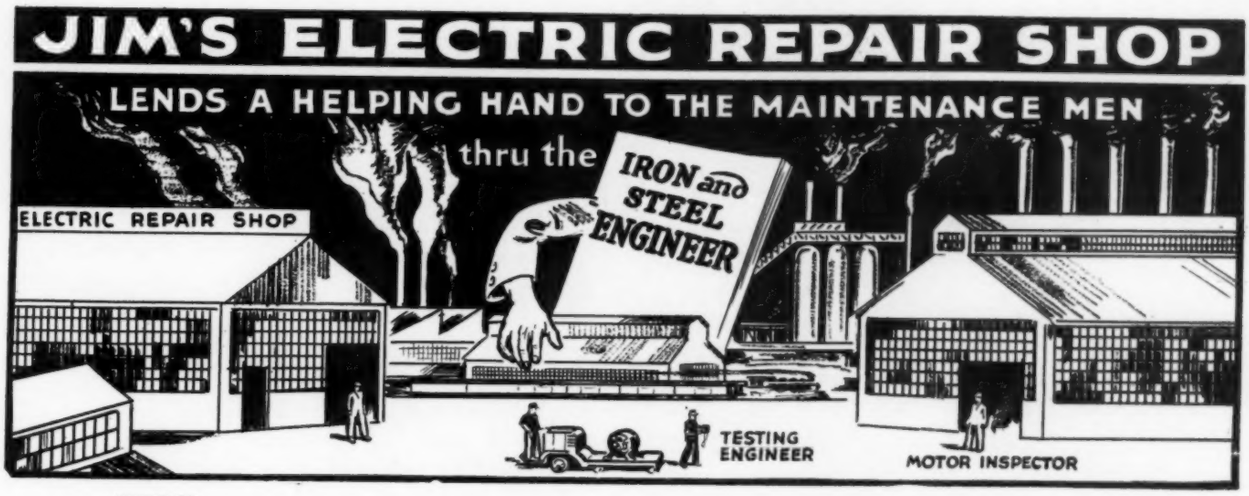
300	150-300	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
300	400-800	230	DC	2-Push Bench	Geared	1930	Chase Brass & Copper Co.	Cleveland, Ohio	GE
400	200-400	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	200-400	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
400	200-400	600	DC	Cold Strip Mill	Geared	1930	United States Aluminum Co.	Alcoa, Tenn.	W
400	400-1000	250	DC	26″ Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26″ Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26″ Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
400	400-1000	250	DC	26″ Cold Mill	Geared	1930	American Steel & Wire Co.	Cleveland, Ohio	GE
500	200-400	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	225-450	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
500	270-750	250	DC	Cold Strip Mill	Geared	1930	Wheeling Steel Corp.	Steubenville, Ohio	GE
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	110-220	230	DC	Tube Mill	Direct	1930	Babcock & Wilcox Co.	Beaver Falls, Pa.	W
600	228-800	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
600	228-800	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
600	300-600	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
600	300-600	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
600	300-600	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
700	300-750	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
700	300-750	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
750	120-360	600	DC	10″ Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill	GE
750	180-450	600	DC	10″ Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill	GE
750	300-700	600	DC	10″ Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill	GE
750	300-700	600	DC	10″ Merchant Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	400-800	600	DC	10″ Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10″ Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10″ Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10″ Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	400-800	600	DC	10″ Merchant Mill	Geared	1930	Inland Steel Co.	Indiana Harbor, Ind.	GE
750	450-900	600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
750	450-900	600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
800	195-495	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	200-643	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
800	270-670	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	100-300	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14″ Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	100-300	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900	250-610	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	310-765	250	DC	10″ Bar Mill	Geared	1930	Carnegie Steel Co.	Youngstown, Ohio	W
900	380-765	250	DC	10″ Bar Mill	Direct	1930	Carnegie Steel Co.	Youngstown, Ohio	W
1000	200-600	600	DC	14″ Merchant Mill	Direct	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
1200	150-300	230	DC	Tube Mill	Geared	1930	Timken Roller Bearing Co.	Canton, Ohio	GE
1250	100-200	600	DC	14″ Merchant Mill	Direct	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
900-1400	40-63-190	380-600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
950-1500	128-202-580	380-600	DC	10″ Merchant Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	GE
1500	250-625	600	DC	14″ Merchant Mill	Geared	1930	Great Lakes Steel Co.	Detroit, Mich.	GE
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
1500-1800	200-240-500	500-600	DC	Expander Reeler		1930	National Tube Co.	McKeesport, Pa.	AC
2000	165-330	600	DC	84″ Aluminum Mill	Direct	1930	Aluminum Co. of America	Alcoa, Tenn.	GE
2250	65-90	600	DC	28″ Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE
2500	100-200	600	DC	14″ Merchant Mill	Geared	1930	Jones & Laughlin Steel Corp.	Pittsburgh, Pa.	GE
3000	65-130	680	DC	32″ Billet Mill	Direct	1930	National Tube Co.	McKeesport, Pa.	W
3000	71-140	650	DC	24″ Merchant Mill	Direct	1930	Weirton Steel Co.	Weirton, W. Va.	GE
3000	90-180	600	DC	144″ Aluminum Mill	Direct	1930	Aluminum Co. of America	Alcoa, Tenn.	GE
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC
3500	165-330	600	DC	96″ Plate Mill	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	AC

A-C ADJUSTABLE SPEED SET DRIVES

1140	480-493-570	6600	25	Merchant Mill	Belted	1930	Carnegie Steel Co.	Youngstown, Ohio	W
2000	590-450	4000	60	Rail Rerolling	Geared	1930	Calumet Steel Co.	Chicago, Ill.	W

REVERSING MILL DRIVES

1250	60-120	600	DC	22″ Bar Mill	Direct	1930	Carnegie Steel Co.	Duquesne, Pa.	W
2500	79-225	700	DC	44″ Slabbing Mill, Vertical Edger	Geared	1930	Illinois Steel Co.	So. Chicago, Ill.	W
3000	65-130	680	DC	32″ Billet Mill	Direct	1930	National Tube Co.	McKeesport, Pa.	W
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	W
5000	40-80	600	DC	44″ Slabbing Mill	Direct	1930	Illinois Steel Co.	So. Chicago, Ill.	W
5000	50-120	700	DC	28″ Rail Mill	Direct	1930	Algoma Steel Corp.	Sault Ste. Marie, Ont.	W
8000	40-100	800	DC	44″ Blooming Mill	Direct	1930	Illinois Steel Co.	Gary, Ind.	GE



JIM'S ELECTRICAL REPAIR SHOP JANUARY, 1931

Since your operating handicaps as well as your suggestions for reducing maintenance costs are of such vital importance to all Iron and Steel Maintenance men, we are extending to you as a New Year's greeting a new department which will set forth your views on maintenance and repairs. We are asking the co-operation of every member, by suggesting that you present your difficult problems in the form of questions, assist in the solution of other members questions and divulge any method you may have for reducing maintenance costs, so they may be printed in this section.

We will print the name and company of those presenting maintenance suggestions or answers to questions asked in this department providing the sender does not request they be withheld. On the other hand we deem it advisable not to print the name of persons asking questions, but we will identify the sender of a question by his initial and the name of the state in which he lives.

OUR 1931 NEW YEAR'S RESOLUTION

1—We realize that the electrical repair shop is an important link in the continuous economic operation of the steel mill. Better repaired electrical equipment will result in longer operating life, which means a lower total cost of repairs, and larger production.

Therefore, we resolve in the coming year to assist the electrical repair shop to increase its efficiency with useful suggestions.

2—We know that unless electrical equipment is properly inspected and maintained in the field the good work performed by the electrical repair shop will be lost. The Motor Inspector is worthy of equal consideration in the solution of his problems.

Therefore, we also resolve to lend him a helping hand with answers to his questions and kindly suggestions to the better performance of his task.

3—We dare not miss the importance of the Test Engineer who is continually in the mill studying the causes of overloaded equipment and determining how the application or operation can be altered to obtain the most economic operation without sacrificing production. Therefore, we further resolve to assist the Test Engineer with suggestions as to how to better his batting average.

YOUR 1931 NEW YEAR'S RESOLUTION

We, the Steel Mill Electrical Repairing, Inspecting and Testing Organizations resolve to co-operate and assist "JIM'S ELECTRICAL REPAIR SHOP" in making our department the most useful part of this periodical by:

1—Submitting my problems to this department for fellow workers suggestions for their proper solution.

2—Submitting my solution to the other fellows problems printed in this department.

3—Submitting my economic methods of performing tasks which will be of interest to my fellow members.

"JIM ASKS THE FIRST QUESTION" FLAT COMMUTATORS

A maintenance man has a 100 H.P., 500 R.P.M., 230 volts, compound wound mill motor driving in parallel with another motor a Blooming mill approach table through a speed reducer having a pinion which has 15 teeth and connected by a flexible coupling having four joints. The commutator has 123 bars, 31 armature coils of which each coil has four conductors one turn each. The control is 14 years old and of the shunt operated magnetic contactor type, with current acceleration. The reversal peaks are 1300 amps and the RMS current is within the rated RMS of the motor. The armature and compound fields show no signs of overheating.

This motor operates satisfactory for four or five months after which flat spots develop in 16 places. These flat spots are two bars in width and also extending one-half a bar in each direction. These flat spots are accompanied by vicious sparking on plugging and reversing.

What can this trouble be laid to?

(Have your answer in by March 1).

IRON & STEEL INDUSTRY
CONSTRUCTION PROGRAM—1930

ROLLING MILLS COMPLETED—1930

COLD STRIP MILLS

Type	Number
12″ Cold Strip Mill	7
16″ Four-High Cold Strip Mill	1
18″ Four-High Cold Strip Mill	1
24″ Cold Strip Mill	1
24″ Four-High Cold Strip Mill	1
Cluster Cold Strip Mill	1
TOTAL	12

STECKEL STRIP MILLS

7½″ Steckel Strip Mill	2
20″ Steckel Strip Mill	1
38″ Steckel Strip Mill	2
TOTAL	5

BILLET SHEET BAR MILLS

21″ Billet Sheet Bar Mill	1
Billet Sheet Bar Mill	1
TOTAL	2

ELECTRIC WELD PIPE MILLS

Electric Weld Pipe Mill	6
TOTAL	6

HOT SHEET MILLS

28″ Hot Sheet Mill	4
29″ Hot Sheet Mill	2
30″ Hot Sheet Mill	15
TOTAL	21

BLOOMING MILLS

32″ Blooming Mill	1
40″ Blooming Mill	2
TOTAL	3

UNIVERSAL MILLS

46″ Universal Mill	1
TOTAL	1

SKELP MILLS

Type	Number
16″ Skelp Mill	1
TOTAL	1

MERCHANT MILLS

8″ Merchant Mill	1
9″ Merchant Mill	1
10″ Merchant Mill	3
14″ Merchant Mill	2
TOTAL	7

BAR MILLS

12″ Three-High Bar Mill	1
32″ Bar Mill	1
TOTAL	2

COLD SHEET MILLS

26″ Cold Sheet Mill	22
TOTAL	22

HOT STRIP MILLS

12″ Hot Strip Mill	1
20″ Four-High Hot Strip Mill	1
28″ Hot Strip Mill	1
TOTAL	3

BUTT WELD PIPE MILLS

Butt Weld Pipe	2
TOTAL	2

SEAMLESS TUBE MILLS

Seamless Tube Mill	3
TOTAL	3

STRUCTURAL MILLS

24″ Structural Mill	1
TOTAL	1

PLATE STRIP MILLS

48″ Plate Strip Mill	1
TOTAL	1

CONSTRUCTION PROGRAM, 1930—*(Continued)*

SHEET JOBBING MILLS

Type	Number
Sheet Jobbing Mill	1
TOTAL	1

OPEN HEARTH FURNACES COMPLETED IN 1930

In 1930 there were 16 Open Hearth Furnaces completed in sizes ranging from 40 tons to 250 tons. At the Bethlehem Steel Company, Lackawanna, N. Y., 6-150 ton furnaces were completed; 6-150 ton furnaces were completed at Great Lakes Steel Corporation, Ecorse, Mich.; 1-40 ton furnace was completed at St. Louis Screw and Bolt Company, St. Louis, Mo., and 3-250 ton furnaces were completed at Youngstown Sheet and Tube Company, Indiana Harbor, Ind.

CONTINUOUS BILLET MILLS

Type	Number
21″ Continuous Billet Mill	1
TOTAL	1

STACKS REBUILT IN 1930

Fourteen stacks were remodeled in 1930. Seven out of the 14 stacks remodeled will have 1000 tons or more capacity. There were six Blast Furnaces dismantled in 1930.

BY-PRODUCT COKE OVENS BUILT IN 1930

There were 578 By-Product Coke Ovens built in 1930 in 11 different plants.

CONSTRUCTION PROGRAM—1931

ROLLING MILLS UNDER CONSTRUCTION—1931

BILLET MILLS

Type	Number
24″ Billet Mill	1
TOTAL	1

ROD MILLS

Rod Mill	2
TOTAL	2

COLD STRIP MILLS

16″ Four-High Cold Strip Mill	4
26″ Four-High Cold Strip Mill	4
TOTAL	8

STECKEL STRIP MILLS

7½″ Steckel Strip Mill	2
TOTAL	2

UNIVERSAL MILLS

40″ Universal Mill	1
TOTAL	1

MERCHANT MILLS

10″ Merchant Mill	2
Merchant Mill	1
TOTAL	3

PLATE STRIP MILLS

Type	Number
Plate Strip Mill	4
TOTAL	4

BLOOMING MILLS

44″ Blooming Mill	2
Blooming Mill	1
TOTAL	3

BEAM MILLS

Beam Mill	1
TOTAL	1

CONTINUOUS PLATE MILLS

96″ Continuous Plate Mill	1
TOTAL	1

BAR MILLS

10″ Alloy Bar Mill	1
10″ Bar Mill	1
TOTAL	2

SEAMLESS TUBE MILLS

Seamless Tube Mill	1
TOTAL	1

CONSTRUCTION PROGRAM, 1931—*(Continued)*

OPEN HEARTH FURNACES UNDER CONSTRUCTION—1931

On December 31, 1930, there were 34 Open Hearth Furnaces under construction in the Iron and Steel Industry ranging in sizes from 100 tons to 400 tons. There are 6-150 ton Open Hearth Furnaces under construction at Bethlehem Steel Company, Sparrows Point, Md.; 1-400 ton furnace at the Ford Motor Company, Fordson, Mich.; 7-150 ton furnaces at Illinois Steel Company, Gary, Ind.; 14-150 ton furnaces at Illinois Steel Company, South Chicago, Ill.; 1-150 ton furnace at Tennessee Coal, Iron and Railroad Company, at Fairfield, Ala.; 3-250 ton furnaces at National Tube Company, McKeesport, Pa.; 2-100 ton furnaces at Wisconsin Steel Company, South Chicago, Ill.

STACKS UNDER CONSTRUCTION—1931

On December 31 there were six stacks under construction. Two of the six furnaces will have 1000 tons or more daily capacity. The stacks under construction are located at American Steel and Wire Company, Cleveland, Ohio; Bethlehem Steel Company, Lackawanna, N. Y.; Bethlehem Steel Company, Sparrows Point, Md.; Carnegie Steel Company, Braddock, Pa.; Carnegie Steel Company, Mingo Junction, Ohio; Carnegie Steel Company, Rankin, Pa.

BY-PRODUCT COKE OVENS UNDER CONSTRUCTION—1931

On December 31 there were 206 By-Product Coke Ovens under construction. At the Consolidated Gas Company of Hunts Point, N. Y., 37 ovens were being built; at the Hudson Valley Fuel Corporation, Troy, N. Y., 31 ovens were under construction, and at the Illinois Steel Company, Gary, Ind., 138 ovens were under construction.

THE IRON & STEEL INDUSTRY AT A GLANCE

1930 Pig Iron production, 31,650,000 tons.
1930 Steel production, 40,000,000 tons.

Additions to open hearth capacity totaled 845,000 tons.

Distribution of Steel Production—1930

Bars	20 %
Sheets	15 %
Pipe	11½%
Shapes	11 %
Plates	11 %
Wire	7½%
Rails	6 %
Tin Plate	6 %
Strips	5½%
All others	6½%
TOTAL	100 %

Peak of Blast Furnace production, month of April, 1930.

Peak of the United States Exports of Iron and Steel occurred in month of March, 1930.

Steel Used By the Electrical Manufacturers

300	tons of Heavy Rails.
51,700	tons of Plates.
11,100	tons of Structural Shapes.
35,100	tons of Bars.
10,700	tons of Hoops, Bands, etc.
241,400	tons of Black Plate and Sheets.
54,400	tons of Tube and Pipe.
7,900	tons of Wire Products.
81,900	tons of Strip Steel.
10,400	tons of all other finished products.
400	tons of Billets and Slabs.
500	tons of Wire Rods.
505,800	tons of Rolled Steel Products used by Electrical Manufacturers.

Alloy Steel Used By the Electrical Manufacturers

1,507	tons of Bars.
281	tons of Black Sheets.
760	tons of Strip Steel.
15	tons of all other finished products.
139	tons of Forgings.
2,702	tons of Alloy Steel used by Electrical Manufacturers.

Steel Producing Ingot Capacity of the United States Is 66,350,000 Gross Tons

Steel producing ingot capacity in the various sections of the United States are as follows:

Pittsburgh District	24.3%
Chicago District	20.2%
Youngstown District	12.0%
Philadelphia District	11.9%
Cleveland District	11.6%
Wheeling District	4.9%
Buffalo District	4.3%
Southern District	3.2%
Ohio River District	2.8%
Western District	2.7%
St. Louis District	1.4%
Eastern District	0.7%
TOTAL	100 %

ELECTRICALLY OPERATED CRANE STATISTICS, 1930

ELECTRIC OVERHEAD TRAVELING CRANES, CHARGERS, HOISTS, PURCHASED BY IRON AND STEEL INDUSTRY

Table No. 1
Trend of Bearing Construction

Number of Cranes Purchased	Cranes Tonnage	Completely Equipped with Anti-friction Bearings	Partially Equipped	Sleeve Bronze Bearings Etc.
3	3	3	.....	.....
1	3½	1	.....	.....
1	4	1	.....	.....
32	5	14	4	14
5	7½	1	3	1
2	8	2	.....	.....
71	10	42	9	20
2	12	.....	.....	2
42	15	25	10	7
26	20	21	3	2
17	25	10	3	4
2	30	1	.....	1
7	40	6	1	.....
6	50	.....	4	2
1	55	1	.....	.....
1	60	.....	1	.....
1	75	1	.....	.....
5	100	1	4	.....
3	125	.....	3	.....
9	150	5	4	.....
3	160	.....	3	.....
4	175	3	1	.....
7	200	3	4	.....
4	225	.....	4	.....
3	275	.....	3	.....
258		141	64	53

Table No. 2

Type of Cranes Purchased	Total
Standard Cranes	97
Standard Cranes with Magnet	21
Standard Cranes with Magnet and Bucket	3
Bucket Cranes	3
Standard Cranes with Sta. Hoist	4
Double Hook, Double Drum, Double Trolley	27
Ladle Cranes	31
Floor Charger—Low Type	8
Soaking Pit Cranes	5
Soaking Pit Cranes—Low Type	2
Stripper	4
Ingot Mold Handling	1
Trailer Trolley	2
Pillar	2
Crane Type Revolving Slab Charger	1
Monorail	2
Pit Crane	1
Unclassified	44
Total	258

COMPILATION

Total Cranes purchased, 258.

Cranes completely equipped with anti-friction bearings	141
Cranes partially equipped with anti-friction bearings	64
Cranes equipped with sleeve-bronze bearings, etc.	53
Total	258
Cranes equipped with Spur Gears	183
Worm Gear reductions	16
Spur and Worm Gears	47
Spur and Herringbone Gears	12
Total	258

1025 Motors furnished. Total Crane Tonnage purchased, 9,944½. Approximate value, $5,000,000.

Items of Interest

PERSONNEL CHANGES

F. F. Brand has been appointed managing engineer of the transformer department of the General Electric Company, Pittsfield, Mass.

R. N. Jessop has been appointed assistant sales manager of the Ohio Electric Manufacturing Company, Cleveland, Ohio.

H. W. King, head of the engineering department of the Morgan Engineering Company, Alliance, Ohio, has been appointed assistant to vice president of the Aetna Standard Engineering Company, Youngstown, Ohio.

F. W. Peek, Jr., has been appointed chief engineer of the Pittsfield, Mass., works of the General Electric Company. Mr. Peek succeeds G. Faccioli, who retired several months ago from active work on account of ill health.

J. J. Dunn, formerly general superintendent of the Ellwood City, Pa., plant of the National Tube Company, has been appointed assistant to vice president with offices at Pittsburgh, Pa. J. W. Offutt is now general superintendent of the Ellwood City plant and G. E. Moyer has been appointed as assistant general superintendent.

E. W. Brown has been appointed general superintendant of the Lorain works of the National Tube Company, succeeding Charles Fell, who has retired from active service. J. L. Mauthe and P. P. Reese have been appointed assistant general superintendents.

C. V. Dodge has been appointed manager of roll and steel castings sales for the United Engineering and Foundry Company, Pittsburgh, Pa. Mr. Dodge succeeds the late William Gardner.

L. F. Rains has been elected president of the A. M. Byers Company, Pittsburgh, Pa. Mr. Rains was formerly vice president of Columbia Steel Corporation at San Francisco, California. He succeeds the late A. H. Beale, who died suddenly on October 28, 1930.

D. H. Wagner, formerly vice president of the Wheeling Corrugating Company, Martins Ferry, Ohio, has been elected president, succeeding W. W. Holloway, who was elected president of the Wheeling Steel Corporation.

B. F. Fairless, first vice president of the Republic Steel Corporation, has announced the appointment of L. E. Creighton as vice president and general manager of the Union Drawn Steel Company of Beaver Falls, Pa.

A. W. Bass was recently appointed director of Budgets by F. A. Merrick, president of the Westinghouse Electric and Manufacturing Company. Formerly Mr. Bass was assistant to the vice president, in which position he was director of Works Records and Statistics, directing works accounting for the company and its subsidiaries. The definite duties performed by Mr. Bass in his former position, such as time studies and works supervisory bonus, will be under the direction of A. Taylor, assistant to the vice president, in addition to his regular duties.

WITH THE MANUFACTURERS

SAVINGS MADE POSSIBLE BY ACROSS-THE-LINE MOTORS

The introduction of the across-the-line type induction motor has made possible a considerable saving in first cost in the combined price of the motor and starter as compared with the standard induction motor using the ordinary starting compensator. These savings in first cost amount to from 6% to 32% in the 7½-30 H. P. sizes for which this type of motor is regularly listed. Although less in its original price this combination of across-the-line motor with push-button control offers some desirable advantages. Maintenance is less because of the simpler starter construction. There are fewer parts to inspect and renew. Push-button control affords greater convenience. Push buttons may be placed close to the operator with additional buttons in remote positions for emergency stopping.

With the same current the starting torque of the across-the-line motor is greater than can be obtained with the ordinary induction motor using a starting compensator.

Mechanically the across-the-line motor is exactly the same as the standard induction motor. In the Reliance line we are now prepared to supply across-the-line motors in the open, fully enclosed or fully enclosed fan-cooled type.

The Pennsylvania Lubricating Company of Pittsburgh, Pa., are distributing a new eight-page bulletin on the Lubrication of Rolling Mills covering Automatic Pressure Lubricating Systems for Roll Necks. The bulletin is well illustrated and interested parties may secure copies of the new bulletin 15 by writing the above company.

The Brown Instrument Company of Philadelphia, Pa., have just issued their new catalog No. 46 on Brown Electric Tachometers. The catalog contains 16 pages with illustrations and covers indicating and recording tachometers in various models, together with the electric generators used in operating same. This new catalog may be obtained by writing the above company.

The Wellman Engineering Company of Cleveland, Ohio, are distributing their new Bulletin No. 92 describing the Wellman Mechanical Gas Producer. The bulletin is well illustrated and contains many tables and charts. Copy may be had on request.

The Combustion Engineering Corporation of New York, N. Y., have prepared a new edition of the General Condensed Catalog. The catalog illustrates and briefly describes the fuel burning and steam-generating equipment manufactured by the Combustion Engineering Corporation and copy may be had on request by writing for Catalog GC-6.

The Freyn Engineering Corporation of Chicago, Ill., are distributing the latest issue of "Freyn Design." In this issue the activities of the Freyn Company in connection with the building of a blast furnace for the Ford Motor Company in England, and also the activities of the Freyn Engineers in the U. S. S. R., are described. In addition there are articles dealing with the modernization of ore bin gates, the application of waste heat boilers at steel

plants and automatic charging of blast furnaces and the fine cleaning of blast furnace gas. Copy of this issue will be mailed on request.

The Elliott Company of Jeannette, Pa., are distributing the latest issue of their publication, "Powerfax." This issue features a new boiler plant, efficient electric ore handling at Fairport Harbor Dock and the question of how often should a condenser be cleaned is discussed. Copies of this issue obtainable on request.

The Roller-Smith Company, 233 Broadway, New York, N. Y., announces a new instrument, the Type PD Direct Current Volt-Ohmmeter which is illustrated and described in Supplement No. 3 to Bulletin No. 100. Copy will be sent to interested parties on request.

Wellman Revolving Car Dumpers is the title of the new Bulletin No. 93 which has been prepared by the Wellman Engineering Company of Cleveland, Ohio. The bulletin contains 12 pages of very interesting information and data is very well illustrated. Copy may be had on request.

Bulletin No. 207 on Type T Heavy Duty Reliance Planer Motors for Reversing Service prepared by the Reliance Electric and Engineering Company of Cleveland, Ohio, is now ready for distribution. Interesting data on construction and application of these motors is included in this 22-page bulletin and copy may be obtained by writing the above company.

Officials of Arthur G. McKee and Company, Cleveland, Ohio, engineers and contractors, announce that an arrangement has been made by the company with the Whessoe Foundry and Engineering Company, Ltd., of Darlington, England, under which the latter company will act as the exclusive manufacturing agent in Great Britain, including England, Scotland, Wales and Ireland, for the manufacture of McKee oil refinery and blast furnace equipment.

Westinghouse Electric Bell Type Annealing Furnaces are described in a new publication recently released by the Westinghouse Electric and Manufacturing Company. These furnaces are of two types, the cylindrical and rectangular , both of which are described and illustrated in this leaflet. Their advantages are close temperature control throughout, gives product a thorough anneal; controlled atmosphere minimizes oxidation, and ease of handling and simplicity of operation effects savings in labor.

Copies of this leaflet may be obtained from any Westinghouse District Office or direct from the Advertising Department, East Pittsburgh, Pa.

An outstanding achievement in the industrial world was made by the A. O. Smith Corporation of Milwaukee during 1930, when it shipped 472,000 tons of electrically-welded pipe to all parts of the United States, compared with 425,000 tons in 1929.

The 1930 tonnage, according to Carl C. Joys, Jr., manager of pipe sales, consisted of about 3,000 miles, or 24,272 carloads. The mileage was nearly the same as in 1929, and the carloads compared with 30,474 in 1929. More heavier pipe was made during the year just closed than in the previous year, the figures indicate.

In the first five months of the company's fiscal year, August 1, 1930, to January 1, 1931, shipments amounted to 216,000 tons, or 9,720 carloads, against 126,000 tons and 8,698 carloads the same 1929 period. Increases for the five months' period come to 71.4% in tons, 11.7% in loads, and 63.4% in miles.

UNIFORM FABRICATED STEEL CONSTRUCTION ANNOUNCED BY E-M.

Electric Machinery Manufacturing Company announces that an arc-welded fabricated steel stator frame construction will now be used for all medium and slow speed E-M Synchronous Motors. A recent change from a two-piece cast-iron stator to a welded steel stator for small size motors complete the changeover to fabricated steel stator frames. This change makes uniform in appearance and general construction the entire line of E-M engine type and coupled pedestal type synchronous motors.

The box type stator construction is used for the entire line of E-M slow speed Synchronous Motors. This type of stator construction gives the following advantages: Increased strength and rigidity, decreased weight, increased ventilation, more pleasing appearance, and uniformity of construction.

REORGANIZATION AND CONSOLIDATION OF PACIFIC COAST FACTORIES

The Trumbull Electric Manufacturing Company of Plainville, Conn., are pleased to announce to the Trade that effective January 1, 1931, the name of the A. G. Electric Manufacturing Company will be changed to the Trumbull Electric Manufacturing Company, Pacific Division, with manufacturing plants located at Seattle and Los Angeles.

The Trumbull Electric Manufacturing Company, Pacific Sales Division, has been organized with headquarters at 432 Fourth street, San Francisco Calif., under the management of H. F. Yost, who will be responsible for the distribution of the products of the Seattle, San Francisco, Los Angeles, Ludlow, Ky., and Plainville, Conn., factories of the Trumbull Electric Manufacturing Company in the Pacific Coast territory, including the States of California, Washington, Oregon, Montana, Utah, Idaho, Wyoming, Arizona, Nevada and Western Canada.

INSULATED ALUMINUM WIRES AND CABLES

General Cable Corporation has recently announced a varied line of insulated aluminum wires and cables under the trade name "Alectral." Heretofore, practically all of the aluminum used in the transmission of electrical energy has been in the form of bare conductors. Its use for this purpose is well known to the electrical industry, and within the past ten years more than 250,000,000 pounds of aluminum have been employed in the production of overhead transmission lines. The introduction of Alectral wires and cables, representing as it does a new development in the field of insulated conductors, enables the electrical engineer to employ the economic features of aluminum in a much broader field.

The initial group of insulated aluminum conductors includes such constructions as network cable, non-metallic underground cable, insulated line wire, tree wire, armored cables, magnet wire, starter cable, and car wiring cable.

A new departure in connection technique has been developed, together with the required fittings and accessories. Connections will be made by applying high pressure to sleeves by means of a specially designed light weight hydraulic press.

MEASURING A HUNDREDTH OF A THOUSANDTH OF AN INCH

The New Electric Gauge, Magnifying Infinitesimal Dimensions Ten Thousand Times, Speeds Up Accurate Measurements

An electric gauge which measures one one-hundred thousandth of an inch, and then magnifies that infinitesimal dimension 10,000 times so that the average workman may speedily and accurately read the result, has been developed by the general engineering laboratory of the General Electric Company.

To make such accurate measurements is usually slow and laborious work. By a method of speeding up measurements where production is great and the need of accuracy to minute proportions is imperative, costs of production would be reduced materially. That is what the electric gauge does—first it measures and then instantaneously it multiplies the measurement so that it can be read easily.

In one process it is necessary to gauge the crankpin hole in pistons. The piston is placed over a spindle and rotated once, while the operator watches the pointer on a scale. Approximate limits beyond which the work is rejected are indicated, the "accept" limit in this case covering three inches on the scale and representing three ten-thousandths of an inch on the work. The gauge can pass hundreds of thousands of pistons with no renewal or refinishing of parts, whereas the usual paddle-type "go" and "no-go" gauges formerly used passed only 400 pistons before requiring refinishing.

The new gauge is suitable for almost any type of measurement, with certain changes in the set-up. It may be used to measure outside dimensions of automobile wrist-pins, the inside dimensions of automobile cylinders, and the thickness of flat materials such as sheet steel or paper. One interesting application in one of the departments is a set-up to measure the distance between the center lines of two holes in the main frame of a motor, to determine the parallelism of their center lines.

Large production in the automotive industry has made a real field for the application of the electric gauge.

The gauge consists essentially of a contact point supported to move through a limited distance in the direction of measurement, say 0.0005". This movement causes a pointer to travel five inches over the scale of an indicating instrument. The 10,000-times magnification of movement is obtained by unbalancing a bridge circuit of four inductances. A 500-cycle alternator supplies power to a small transformer which, in turn, supplies power to the four inductances. Two of these are small coils in the electric gauge head, which is about 5x2½x1½ inches in size. The inductance of these is varied by the movement of a pivoted steel lever armature, one end of which moves between the coils as the contact point on the other end conforms to the surface of the piece being measured. The contact point is in the gauge spindle, which is made to fit the work. The other two inductances of the bridge, together with the transformer and indicating instrument, are mounted in an indicating unit, 12x12x12 inches in dimensions, which is placed in easy view of the operator.

The long life of the spindle of the electric gauge has been obtained by having the bearing surfaces made of Carboloy (cemented tungsten carbide). The contact point which explores the piece is a diamond. The contact pressures are sufficiently low so that the material being gauged will not be scratched.

The gauge is calibrated in place simply by adjusting the distance between two small coils in the gauge head so as to bring the pointer on the scale as desired. This is done with suitable master ring gauges of the minimum and maximum limits. In applying the gauge to the innumerable varieties of parts in present-day production the indicating unit, gauge head and power supply are similar for practically all applications. The spindle and the mounting of the gauge head vary with the application.

Recording instruments for use with the electric gauge are being developed, and relays for controlling operations based on thickness of material can be applied.

ASSOCIATION NOTES

Copies of the group picture, which was taken on the Inspection Trip at the Wheeling Steel Corporation in Steubenville, Ohio, on December 3, may be obtained from Miller and Son of 183 North Fourth street, Steubenville, Ohio. Price per copy is $1.50.

Electric Heating and Welding Conference under the auspices of Pennsylvania State College and Association of Iron and Steel Electrical Engineers will be held on January 21, in the Blue Room of the William Penn Hotel, Pittsburgh, Pa. The program, consisting of eight very interesting papers, will start at 9:30 a. m.

OBITUARIES

It is with regret that we announce the death of Ralph H. Plumb, president of the Buffalo Bolt Company, North Tonawanda, N. Y., on January 3. Mr. Plumb was an active member of the Association of Iron and Steel Electrical Engineers and was very active in its affairs. The membership of the A. I. & S. E. E. offer its sympathies and condolences to the relatives.

William Gardner, vice president and a director of the United Engineering and Foundry Company, Pittsburgh, Pa., died at his home in this city on December 28. Mr. Gardner was manager of sales of rolls and rolling mill equipment and had been associated with the United Engineering and Foundry Company for nearly forty years.

A. W. Griffith, formerly assistant general superintendent of the Carnegie Steel Company in the Youngstown District, died at the home of his son in McDonald, Ohio, on December 15.

BUILT FROM ROLLED STEEL

PATENTED

HOT METAL HANDLING EQUIPMENT

COMBINES STRENGTH-STABILITY-WITH LOW DEAD WEIGHT AND INSURES DECREASED MAINTENANCE AND OPERATING EXPENSE

STANDARD 75 TON SHORT POUR HOT METAL CAR WITH REMOVABLE COVER

STANDARD 125 TON OPEN HEARTH LADLE WITH 1 OR 2 MANIPULATORS

STANDARD 70 TON LONG POUR KLING TYPE HOT METAL CAR WITH CONE TOP

MANUFACTURED BY

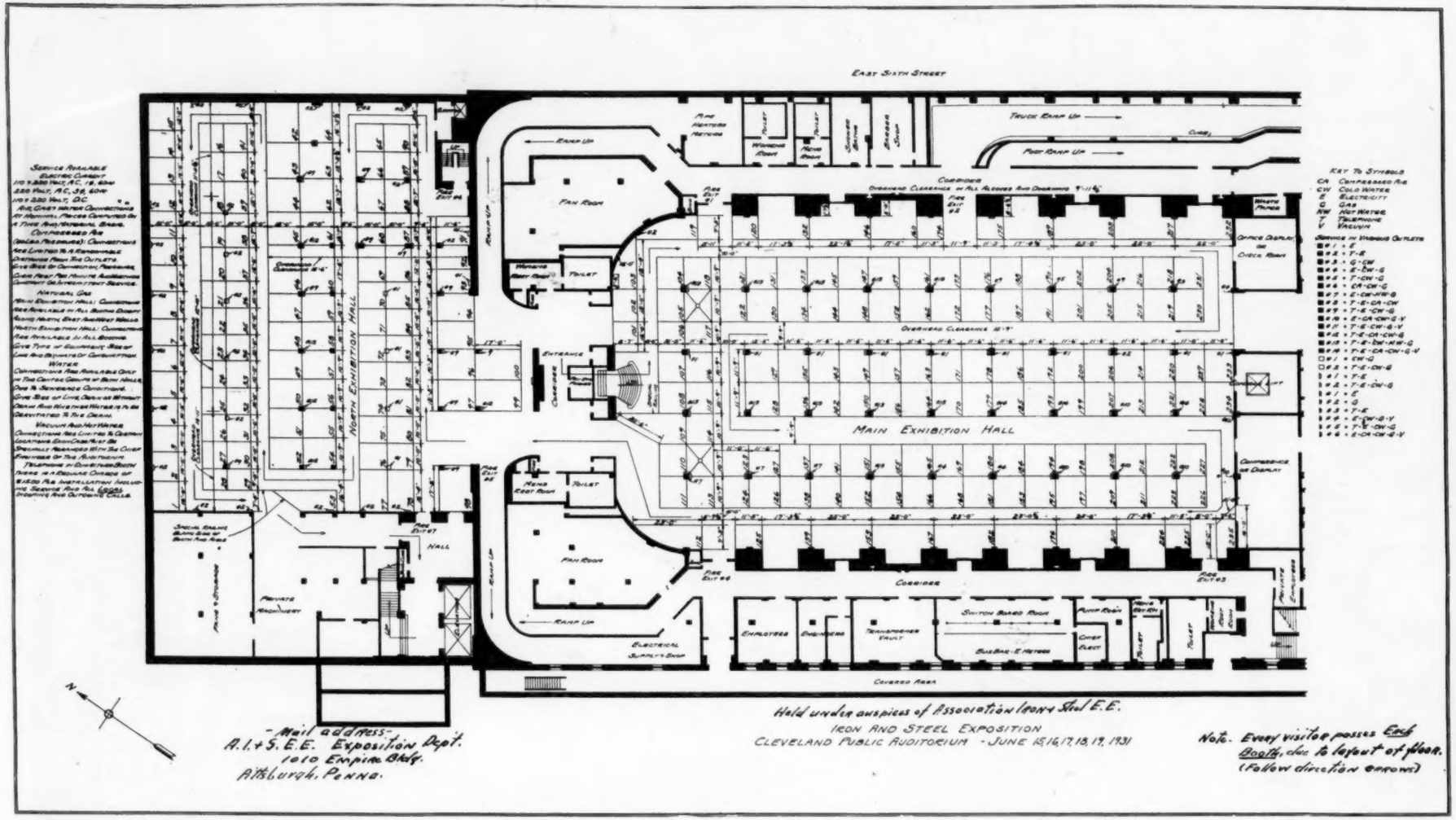
THE WILLIAM B. POLLOCK COMPANY

YOUNGSTOWN OHIO

IRON AND STEEL EXPOSITION

CLEVELAND, O., JUNE 15-16-17-18-19, 1931

THE FIFTY MILLION DOLLAR MARKET FOR STEEL MILL EQUIPMENT



Floor plan of the Iron and Steel Exposition held under the auspices of the Electrical, Mechanical, Combustion, Lubrication and Safety Engineering Divisions of the Association of Iron and Steel Electrical Engineers, Cleveland, Ohio, June 15-19, 1931.

You will note that the arrangements of booths are such that every visitor will be required to pass each and every booth in the entire Exposition. To our knowledge this is the first time that any Industrial Exposition has been laid out along these lines.